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REVISED  
DRAFT REPORT  
on  
VERIFICATION STEP  
for  
CONFIRMATION STUDY ON  
HAZARDOUS WASTE SITES  
at  
NAVAL EDUCATION AND TRAINING CENTER  
NEWPORT, R.I.

February 28, 1984  
Revised May 8, 1984

Prepared for:

Northern Division  
Naval Facilities Engineering Command  
Building 77-L, U.S. Naval Base  
Philadelphia, PA 19112

Prepared by:

Loureiro Engineering Associates  
10 Tower Lane  
Avon, CT 06001

and

York Wastewater Consultants  
One Research Drive  
Stamford, CT 06906

Comm. No. 502-10

A/E Contract No. N62472-83-C-1154

4  
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# **LEA LOUREIRO ENGINEERING ASSOCIATES**

*a professional corporation*  
**CONSULTING ENGINEERS**

10 TOWER LANE  
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May 8, 1984

Commanding Officer NORDIV  
Naval Facilities Engineering Command  
Bldg. 77-L  
Philadelphia, PA 19112

Att: Thomas Sheckels, Code 114

Re: Draft Report on Verification Step  
for Confirmation Study on  
Hazardous Waste Sites  
at Naval Education and Training Center  
Newport, RI.  
A/E Contract No. N62472-83-C-1154

Gentlemen:

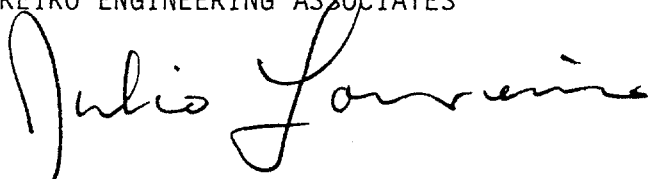
We are transmitting herewith our revised "Draft Report on Verification Step for Confirmation Study on Hazardous Waste Sites at Naval Education and Training Center - Newport, R.I." requested by NORDIV by letter dated April 9, 1984. The report presents all the data obtained in the verification step sampling and analysis on six sites. The report also presents recommendations for the characterization step sampling and analysis on six sites. We are prepared to begin the proposed characterization phase of the work immediately after Navy authorization.

It has been a pleasure working with representatives of the Navy on this project and we look forward to the characterization step and completion of the confirmation study.

Please feel free to call if you have any questions.

Very truly yours,

LOUREIRO ENGINEERING ASSOCIATES



Julio Loureiro, P.E.  
President

JL:kd

Encl.

## TABLE OF CONTENTS

	<u>PAGE</u>
LETTER OF TRANSMITTAL	
TABLE OF CONTENTS	i
LIST OF TABLES	iv
LIST OF FIGURES	vi
LIST OF APPENDICES	vii
<u>A. INTRODUCTION</u>	A-1
1. Scope and Purpose	A-1
2. Initial Assessment Study (IAS)	A-3
<u>B. COLLECTION OF SAMPLES</u>	B-1
1. General	B-1
2. Sediment Sampling Methods	B-1
3. Mussel Sampling Methods	B-2
4. Soil Sampling Methods	B-2
5. Leachate Sampling Methods	B-2
6. Surface Water Sampling Methods	B-3
7. Ground Water Sampling Methods	B-3
8. Sample Containers and Preservation	B-4
9. Sample Identification and Custody	B-5
10. McAllister Point Landfill Samples	B-9
11. Melville North Landfill Samples	B-12
12. Tank Farm One Samples	B-14
13. Tank Farm Four Samples	B-16
14. Gould Island Disposal Area Samples	B-18
15. Gould Island Electroplating Shop Samples	B-20
16. Control Samples	B-22
<u>C. LABORATORY ANALYSIS</u>	C-1
1. Basic Analytical References	C-1
2. Priority Pollutant Analyses	C-1
3. Metals Analyses	C-2
4. Polychlorinated Biphenyls Analyses	C-4
5. Miscellaneous Analyses	C-6
6. Quality Control/Quality Assurance	C-6
7. Results of Analytical Tests on Samples Collected	C-8
<u>D. FINDINGS AT SITE NO. 01 McALLISTER POINT LANDFILL</u>	D-1
1. History of Waste Disposal	D-1
2. Existing Site Conditions	D-2
3. Hydrogeological Data	D-2
4. Analytical Data on Samples Collected	D-3
5. Evaluation of Available Data	D-3
6. Location of Suspected Contaminant Sources	D-7
7. Plan of Action for Further Studies	D-7

## TABLE OF CONTENTS (Continued)

	<u>PAGE</u>
<u>E. FINDINGS AT SITE NO. 02 MELVILLE NORTH LANDFILL</u>	E-1
1. History of Waste Disposal	E-1
2. Existing Site Conditions	E-1
3. Hydrogeological Data	E-2
4. Analytical Data on Samples Collected	E-2
5. Evaluation of Available Data	E-2
6. Location of Suspected Contaminant Sources	E-5
7. Proposed Remedial Measures	E-5
<u>F. FINDINGS AT SITE NO. 07 TANK FARM ONE</u>	F-1
1. History of Waste Disposal	F-1
2. Existing Site Conditions	F-1
3. Hydrogeological Data	F-2
4. Analytical Data on Samples Collected	F-4
5. Evaluation of Available Data	F-4
6. Location of Suspected Contaminant Sources	F-4
7. Plan of Action for Further Studies	F-6
<u>G. FINDINGS AT SITE NO. 12 TANK FARM FOUR</u>	G-1
1. History of Waste Disposal	G-1
2. Existing Site Conditions	G-1
3. Hydrogeological Data	G-2
4. Analytical Data on Samples Collected	G-2
5. Evaluation of Available Data	G-2
6. Location of Suspected Contaminant Sources	G-4
7. Plan of Action for Further Studies	G-4
<u>H. FINDINGS AT SITE NO. 14 GOULD ISLAND DISPOSAL AREA</u>	H-1
1. History of Waste Disposal	H-1
2. Existing Site Conditions	H-1
3. Hydrogeological Data	H-2
4. Analytical Data on Samples Collected	H-2
5. Evaluation of Available Data	H-2
6. Location of Suspected Contaminant Sources	H-4
7. Plan of Action for Further Studies	H-4
<u>I. FINDINGS AT SITE NO. 17 GOULD ISLAND ELECTROPLATING SHOP</u>	I-1
1. History of Waste Disposal	I-1
2. Existing Site Conditions	I-1
3. Analytical Data on Samples Collected	I-1
4. Evaluation of Available Data	I-2
5. Plan of Action for Further Studies	I-2

TABLE OF CONTENTS (Continued)

	<u>PAGE</u>
<u>J. TOXICITY DATA</u>	
1. General	J-1
2. Cadmium	J-1
3. Copper	J-2
4. Cyanide	J-4
5. Lead	J-5
6. Nickel	J-7
7. PBHC (Petrochemicals)	J-8
8. Benzene, Toluene, Xylene (BTX)	J-11

## LIST OF TABLES

<u>No.</u>	<u>Title</u>	<u>Page</u>
1	Verification Step Sampling and Control Stations	A-2
2	Sample Containers and Field Preservation	B-6
3	Codes Used in Sample Identification	B-8
4	Samples Collected - Verification Step Site No. 01 - McAllister Point Landfill	B-10
5	Samples Collected - Verification Step Site No. 02 - Melville North Landfill	B-13
6	Samples Collected - Verification Step Site No. 07 - Tank Farm One	B-15
7	Samples Collected - Verification Step Site No. 12 - Tank Farm Four	B-17
8	Samples Collected - Verification Step Site No. 14 - Gould Island Disposal Area	B-19
9	Samples Collected - Verification Step Site No. 17 - Gould Island Electroplating Shop	B-21
10	Control Samples Collected - Verification Step	B-23
11	Summary of Sediment and Mussel Sample Analytical Data Site No. 01 - McAllister Point Landfill (Nov., 1983)	D-4
12	Summary of Organics and Pesticides Priority Pollutant Analytical Data on Soils and Leachate Site No. 01 - McAllister Point Landfill (Nov., 1983)	D-5
13	Summary of PCB, Metals, Cyanide and Phenol Priority Pollutant Analytical Data on Soils and Leachate Site No. 01 - McAllister Point Landfill (Nov., 1983)	D-6
14	Proposed Characterization Samples - Site No. 01 - McAllister Point Landfill	D-10
15	Summary of Sediment and Mussel Sample Analytical Data Site No. 02 - Melville North Landfill (Nov., 1983)	E-3
16	Summary of Soil Sample Analytical Data Site No. 02 - Melville North Landfill (Nov., 1983)	E-4
17	Proposed Characterization Samples - Site No. 02 - Melville North Landfill	E-5

LIST OF TABLES (Continued)

<u>No.</u>	<u>Title</u>	<u>Page</u>
18	Summary of Soil Sample Analytical Data Site No. 07 - Tank Farm One (Nov., 1983)	F-5
19	Summary of Groundwater Sample Analytical Data Site No. 07 - Tank Farm One (Nov., 1983)	F-5
20	Proposed Characterization Samples - Site No. 07 - Tank Farm One	F-7
21	Summary of Surface Water, Soil and Sediment Sample Analytical Data Site No. 12 - Tank Farm Four (Nov., 1983)	G-3
22	Proposed Characterization Samples - Site No. 12 - Tank Farm Four	G-6
23	Summary of Sediment and Mussel Sample Analytical Data Site No. 14 - Gould Island Disposal Area (Dec., 1983)	H-3
24	Proposed Characterization Samples - Site No. 14 - Gould Island Disposal Area	H-5
25	Summary of Sediment and Mussel Sample Analytical Data Site No. 17 - Gould Island Electroplating Shop (Dec., 1983)	I-3
26	Proposed Characterization Samples - Site No. 17 - Gould Island Electroplating Shop	I-4



## LIST OF FIGURES

<u>No.</u>	<u>Title</u>	<u>Following Page</u>
1	Vicinity Plan	A-1
2	Verification Step - Sites Investigated and Control Sampling Stations	A-1
3	Verification Sampling Points - Site No. 01 McAllister Point Landfill	B-9
4	Verification Sampling Points - Site No. 02 - Melville North Landfill	B-12
5	Verification Sampling Points - Site No. 07 - Tank Farm One	B-14
6	Verification Sampling Points - Site No. 07 - Tank Farm One - Oil Water Separator	B-14
7	Verification Sampling Points - Site No. 12 - Tank Farm Four	B-16
8	Verification Sampling Points - Site No. 14 - Gould Island Disposal Area	B-18
9	Verification Sampling Points - Site No. 17 - Gould Island Electroplating Shop	B-20
10	Proposed Characterization Sampling Points - Site No. 01 - McAllister Point Landfill	D-10
11	Proposed Characterization Sampling Points - Site No. 02 - Melvill North Landfill	E-6
12	Proposed Characterization Sampling Points - Site No. 07 - Tank Farm One	F-7
13	Proposed Characterization Sampling Points - Site No. 07 - Tank Farm One - Oil Water Separator	F-7
14	Proposed Characterization Sampling Points - Site No. 12 - Tank Farm Four	G-5
15	Proposed Characterization Sampling Points - Site No. 14 - Gould Island Disposal Area	H-5
16	Proposed Characterization Sampling Points - Site No. 17 - Gould Island Electroplating Shop	I-4

## APPENDIX

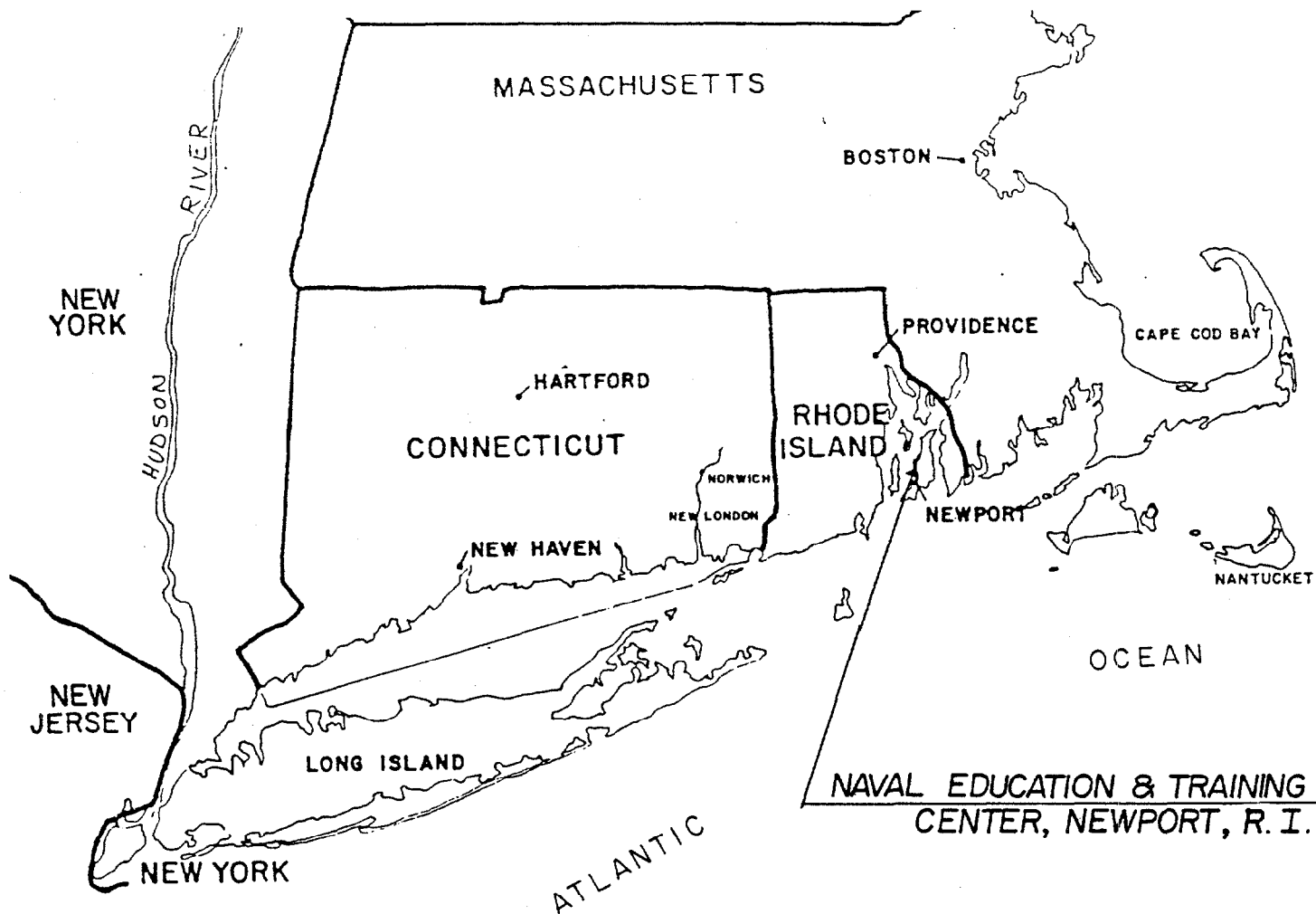
- A. YWC Sample Label
- B. YWC Sample Custody Sheets and YWC Laboratory Services Request/Custody Sheet
- C. YWC Laboratory Reports
- D. QA/QC Summary

## A. INTRODUCTION

### 1. Scope and Purpose

This report covers the results of the verification step of confirmation studies at six sites where hazardous wastes were suspected to be causing adverse effects on the environment due to past waste disposal practices at the Naval Education and Training Center (NETC), Newport, Rhode Island (see Vicinity Plan, Figure 1). The purpose of the verification step was to locate sources of contamination, determine the presence of specific toxic and hazardous materials and determine generalized site hydrogeology. The six sites are listed in Table 1 and the locations are shown on Figure 2. In addition to the sampling program for the six disposal sites, sampling was conducted at two control sites as listed in Table 1 and shown on Figure 2.

The sites to be evaluated were selected in the Initial Assessment Study (IAS) completed for the Naval Education and Training Center in March, 1983. The IAS was the first phase of the Navy Assessment and Control of Installation Pollution (NACIP) program designed to identify contamination of Navy lands resulting from past operations and to institute corrective measures as needed. The second phase of the NACIP program is the confirmation study; this report covers the first step of the confirmation phase (verification) and will be followed by a final report after the characterization step is completed. The goal of the confirmation study is to confirm or refute the existence of contamination, and if contamination is present, to quantify the extent of the problem. The additional work required to complete the characterization step is described in this report. When complete, the final report will include the results of the entire confirmation study (verification and characterization) and will present remedial action plans, if required, to control and mitigate contamination. Institution of the remedial measures will constitute the third and last phase of the NACIP program.



CONFIRMATION STUDY  
ON HAZARDOUS WASTE SITES  
NEWPORT NAVAL EDUCATION &  
TRAINING CENTER

## VICINITY PLAN



York Wastewater Consultants, Inc.  
Stamford, Connecticut



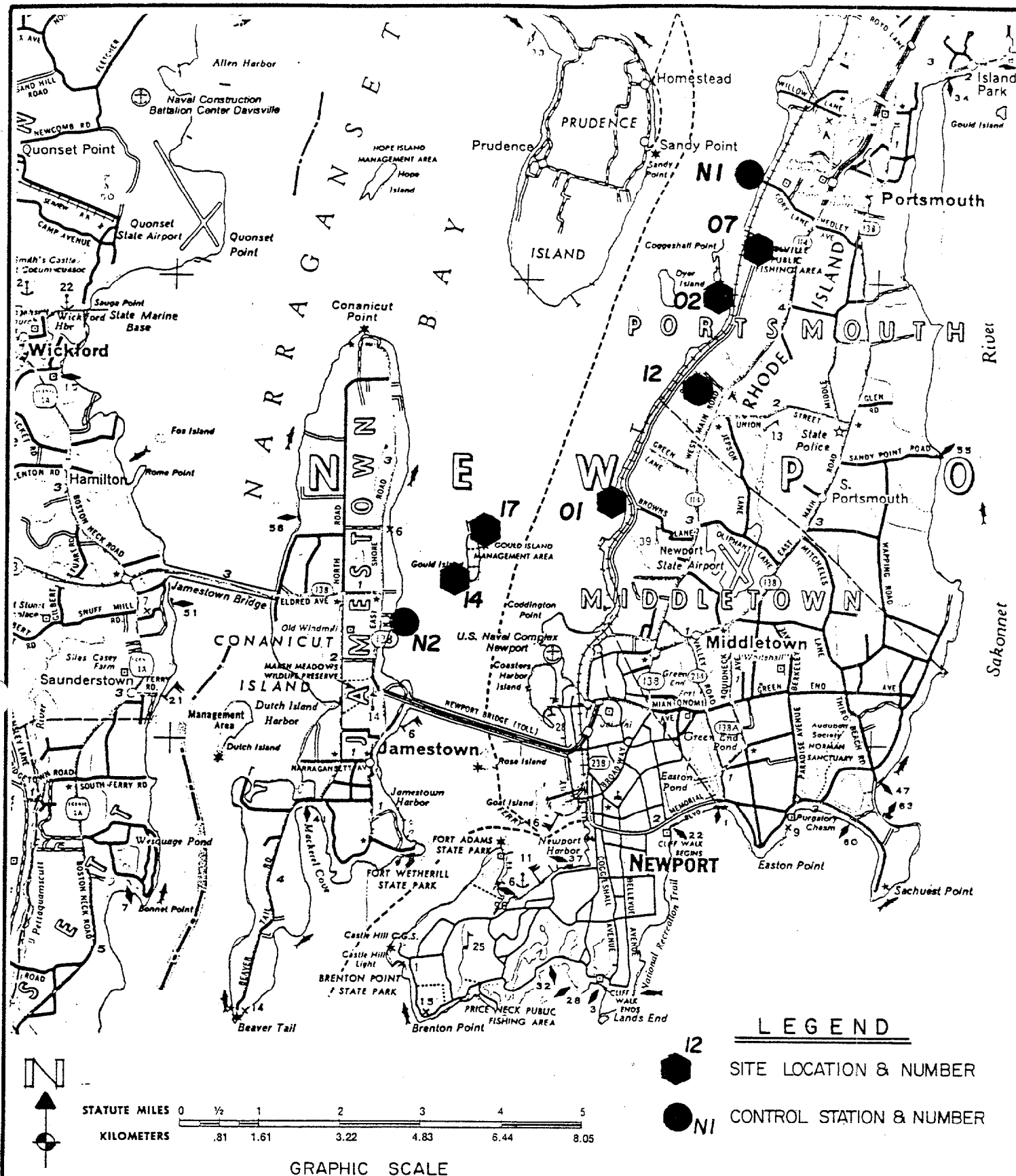
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AVON, CT.

FEB. 28, 1984

FIG. NO. 1



CONFIRMATION STUDY  
ON HAZARDOUS WASTE SITES  
NEWPORT NAVAL EDUCATION &  
TRAINING CENTER

VERIFICATION STEP  
SITES INVESTIGATED  
& CONTROL SAMPLING STATIONS



York Wastewater Consultants, Inc.  
Stamford, Connecticut



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FEB. 28, 1984

FIG. NO. 2

TABLE 1  
VERIFICATION STEP SAMPLING SITES AND CONTROL STATIONS

<u>Site No.</u>	<u>Site Name</u>	<u>Type of Hazardous Waste Disposal Activity</u>
01	McAllister Point Landfill	Landfilling of NETC wastes for 20 years; PCB-contaminated oils; other waste oils; spent acids, paints and solvents
02	Melville North Landfill	Similar to McAllister Point Landfill
07	Tank Farm One	Burial of light oil and gasoline tank bottom sediments
12	Tank Farm Four	Burial of residual fuel oil tank bottom sediments
14	Gould Island Disposal Area	Burial of electroplating wastes
17	Gould Island Electroplating Shop	Discharge of electroplating wastewaters into Narragansett Bay
N1	Control Station at end of Corey Lane, Portsmouth, Rhode Island	None suspected or evident near the sampling point
N2	Control Station off Rte. 138 north of Newport Bridge, Jamestown, Rhode Island	None suspected or evident near the sampling point

This report presents the details of the sampling and analysis program conducted in the verification step. An environmental analysis of the data is presented for each site along with recommendations for a plan of action on each site.

The work described herein was carried out under A/E Contract No. N62472-83-C-1154 by Loureiro Engineering Associates of Avon, CT with laboratory analyses and other support being provided by York Wastewater Consultants of Stamford, CT.

## 2. Initial Assessment Study

The Initial Assessment Study (IAS) performed by Envirodyne Engineers, Inc. at the Naval Education and Training Center covered a total of 18 potentially contaminated sites. Each of the sites was evaluated with regard to contamination characteristics, migration pathways and pollutant receptors. The study concluded that, while none of the sites posted an immediate threat to human health or the environment, the following nine sites warranted a confirmation study: McAllister Point Landfill, Melville North Landfill, Tank Farms One through Five, Gould Island Disposal Area and Gould Island Electroplating Shop. However, the IAS recommended that the confirmation studies be conducted at Tank Farms Two, Three and Five only if contamination is found at Tank Farm Four. As shown in Table 1, the verification step included only six of the nine sites.

## B. COLLECTION OF SAMPLES

### 1. General

The sampling program for the verification step was based on the data presented in the IAS, supplemented by data obtained on a field reconnaissance in October, 1983. The selection of sampling stations and parameters for laboratory analysis was based on hazardous waste constituents which were known or suspected to be present at each site. The types of samples were selected on the basis of environmental importance (e.g., food sources, food chain, ground water), availability of the animals or substrate at or near each site and the possibility that harmful constituents might have an adverse effect. To obtain the highest probability that adverse effects, if occurring, would be detected, sampling stations were located as close as possible to the potential points of contamination.

### 2. Sediment Sampling Methods

Sediment samples were collected with a hand coring device although in some locations (because of the presence of very coarse sediment materials such as rocks, boulders and stones) it was necessary to sample by scooping the top layer of sediment into a sample container. It was the intent to collect three sediment samples at each designated sediment sampling station - a surface sample, and samples at depths of one and two feet - although only the surface sediment samples were intended for laboratory examination in the verification step. The sediment samples at greater depths were intended for use, if necessary, in the characterization step; these were obtainable only at the three Melville North Landfill sampling stations and at one station at the Gould Island Electroplating Shop site.

The hand coring device consisted of a 1-1/2 inch diameter transparent plastic pipe. The lower end of the pipe was fitted with a coupling having a saw-tooth end to aid in forcing the corer into the sediment. A tight-fitting



rubber stopper was placed in the lower end of the device before lowering the tube onto the surface of the sediment. The stopper was pulled up by a cord at approximately the same rate as the sediment was penetrated. Upon withdrawal from the water, the rubber stopper prevented loss of the core (except with very coarse sediment materials). The core was removed from the tube by first pulling the stopper past a vent hole in the side of the pipe after which the core could be removed into sample containers by gravity with the aid of some agitation.

### 3. Mussel Sampling Methods

Mussels were collected by hand from the intertidal zone. An effort was made to include only the edible blue mussel (Mytilus edulis) in the sample although a few others may have been collected. The laboratory was instructed to analyze only the edible blue mussel. In most cases, the sample (at least 100 animals, 1-1/2 to 2 inches long) was gathered in an area covering no more than a 50-foot length of shoreline.

### 4. Soil Sampling Methods

Soil samples were hand excavated by shovel and, where necessary, by use of a pick or crow bar to loosen material. Before each use, the sampling implements were cleaned with hexane and/or inserted several times into the soil near the sampling point. At the desired depth, a soil sample was removed with a shovel and placed on a clean polyethylene sheet from which it was transferred into appropriate sample containers. The waste hexane and the used polyethylene sheets were appropriately discarded after use on each sample.

### 5. Leachate Sampling Methods

Leachate samples were collected only at the McAllister Point Landfill where liquid was observed discharging from the landfill at two locations at the surface adjacent to Narragansett Bay. No attempts were made to collect subsurface leachate flows in the verification step.

At one location, there was a significant flow out of the face of the landfill following each high tide. This flow was sampled by dipping with a glass container with the mouth pointed upstream and transferring the sample into the appropriate sample containers. The 50-milliliter sample vial for examination for volatile compounds was dipped so that it was filled to overflowing with the mouth pointed upstream, and then capped to exclude air. The container used to dip the sample was appropriately discarded after use on each sample.

At the other observed leachate discharge, liquid was trickling out of numerous places at an exposed face of solid waste deposits. Two places were selected for sampling based on suitability for collecting the small trickle of flow without picking up sediments or other foreign material in the sample. At both places, a small trough was formed of aluminum foil to collect the trickling leachate and to conduct it into a bottle from which the sample was transferred to appropriate sample bottles. The 50-milliliter sample vial for examination for volatile compounds was collected to overflowing at the aluminum trough and capped to exclude air.

#### 6. Surface Water Sampling Methods

One surface water sample was collected at Tank Farm Four. This sample was collected on the south side of the site where, in wet weather, groundwater was seeping out to form a small stream. This flow was sampled by dipping with a glass container with the mouth pointed upstream and transferring the sample into the appropriate sample containers. The container used to dip the sample was appropriately discarded after use.

#### 7. Ground Water Sampling Methods

Ground water samples were collected from two locations at Tank Farm One, one at a 36-inch diameter ground water observation pit near the south bank of Melville Pond and the other from a ground water collection pipe system normally discharging into an oil-water separator (which was bypassed during sampling).

The ground water observation pit was sampled by pumping directly into appropriate sample containers. The pump was an electrically-driven peristaltic pump; power was obtained from a gasoline engine-driven generator. The polypropylene suction tubing was weighted and the end submerged about one foot below the water surface in the pit. The pump was operated about five minutes before collecting the sample. No attempt was made to draw down the water level in the pit prior to sampling.

The ground water collection pipe system was sampled by direct discharge from an open end pipe into appropriate sample containers. The oil-water separator was bypassed for a minimum of 15 minutes into a nearby holding basin where the samples were collected at the discharge pipe at the retaining wall on the east end of the basin.

#### 8. Sample Containers and Field Preservation

Five types of sample containers were used:

- Two-liter glass bottle with Teflon-lined screw cap.
- One-liter wide-mouth glass bottle with Teflon- or aluminum foil-lined screw cap.
- 500-milliliter plastic bottle with Teflon-lined screw cap.
- 50-milliliter glass, Teflon septum-capped vial.
- Zip-loc plastic bag (with sample pre-wrapped in aluminum foil).

All samples were preserved by placing them in coolers chilled with ice. In addition, the following preservation techniques were used for specific analyses on water and leachate samples:

- |           |                                                                                          |
|-----------|------------------------------------------------------------------------------------------|
| Metals -  | Add 1-2 milliliters of concentrated nitric acid (pH < 2)                                 |
| BTX -     | Add 1-2 milliliters of concentrated hydrochloric acid (pH < 2)                           |
| Cyanide - | Add 1-2 milliliters of 50% sodium hydroxide (pH > 12)                                    |
| Phenols - | Add 1-2 milliliters of phosphoric acid (pH < 4) and 1 $\pm$ gram copper sulfate crystals |

The 50-milliliter vials for volatile organic and BTX testing were slowly filled to overflowing and capped to exclude air in water and leachate samples; for soil samples, the vials were filled as much as practical and then tightly capped.

Table 2 shows a summary of the sample containers and field preservation techniques for the various types of samples collected.

#### 9. Sample Identification and Custody

Each sample container was labeled as soon as possible after collection (and after addition of preservatives, if required) with a pre-numbered peel off gummed label furnished by the laboratory. A copy of a typical label is shown in Appendix A. Each label was composed of three parts, each part having the same pre-printed laboratory sample number to facilitate cross references to Chain-of-Custody sheets and Laboratory Services Request/Custody sheets. The three-section label served the functions of (1) maintaining a seal by affixing the large portion of the label to both the container lid and body of the container; (2) maintaining chain-of-custody records by affixing the smallest portion of the label to the Chain-of-Custody sheet; and (3) minimizing numerical transcription errors by affixing the lower part of the label to the Laboratory Services Request/Custody sheet.

The large main section of each label was filled out to provide the following information:

- Job number and client
- Date of sample collection
- Check box to indicate that sample is to be saved
- Sample identification number

The lower part of the label was also filled out with the sample identification number identical to that entered on the main section of the label. The three parts of the label were then placed on the sample container,

TABLE 2  
SAMPLE CONTAINERS AND FIELD PRESERVATION

Sample Type	Container Used		Minimum Sample Quantity	Parameters to be Analyzed**	Preservation Techniques
	Description	Suffix Used in Sample Ident.*			
Sediment	Glass bottle, wide-mouth, one-liter	-	250 grams	PCB, VOC Metals	Cool, 4°C
Mussels	Pre-wrapped in aluminum foil and placed in plastic bag	-	100 mussels	Metals, PCB	Cool, 4°C
Soil	Vial, 50-milliliter	A	20 grams	VOC	Cool, 4°C
	Glass bottle, wide-mouth one-liter	B	100 grams	Other Priority Pollutants	Cool, 4°C
Leachate	Vial, 50-milliliter	A	50 milliliters	VOC	Cool, 4°C
	Glass bottle, two-liter	B	2 liters	Acid & B/N Extract	Cool, 4°C
	Plastic bottle 500-milliliter	C	500 milliliters	Metals	HNO <sub>3</sub> to pH < 2
	Plastic bottle 500-milliliter	D	500 milliliters	Cyanide	NaOH to pH > 12, Cool, 4°C
	Glass bottle, wide-mouth, one-liter	E	500 milliliters	Phenols	1 Gram CuSO <sub>4</sub> H <sub>3</sub> PO <sub>4</sub> to pH < 4, Cool, 4°C
Surface Water	Glass bottle, wide-mouth, two-liter	A	2 liters	Pet.-Based H.C.	Cool, 4°C
	Plastic bottle, 500-milliliter	B	500 milliliters	Lead	HNO <sub>3</sub> to pH < 2
Ground Water	Vial, 50-milliliter	A	50 milliliters	BTX	HCl to pH 1-2
	Glass bottle, wide-mouth two-liter	B	2 liters	Pet.-Based H.C.	Cool, 4°C
	Plastic bottle, 500-milliliter	C	500 milliliters	Lead	HNO <sub>3</sub> to pH < 2

\*See Table 3

\*\*All samples were not analyzed for the indicated parameters.

Sample Custody sheet and Laboratory Services Request/Custody sheet. The executed Sample Custody and Laboratory Services Request/Custody sheets are included in Appendix B for the samples collected.

The sample identification entered on the labels consisted of three parts separated by dashes; e.g. 01-09-MS. The first two digits were the site number at which the sample was collected (see Table 1 for site numbers; control stations were assigned numbers N1 and N2). The next two digits were the station number at the site (see Figures 2 to 9). The letters in the last part of the sample identification designated the type of sample (see Table 3 for a complete list of codes). The above example represents a sample of mussels collected at Station 09 at Site No. 01, the McAllister Point Landfill.

To maintain control over the sample from its origination in the field sampling program through receipt and analysis in the laboratory, a chain-of-custody program was instituted for convenience in handling and legal considerations.

At the sampling site, the person who collected the sample placed it in the appropriate container and transferred the sample to the project manager who was responsible for (or delegating responsibility for) addition of proper preservatives to the samples. The project manager then completed all the necessary labeling and preparation of Sample Custody and Laboratory Services Request/Custody sheets. The Sample Custody sheet was signed by the person collecting the sample and by the project manager.

The samples were then turned over to the custody of an on-site representative of the laboratory who also signed the Custody Sheet and became responsible for continuing preservation, storage and transportation of the samples to the laboratory. Samples were kept on ice in coolers in a vehicle kept locked when not attended.

TABLE 3  
CODES USED IN SAMPLE IDENTIFICATION

<u>Code</u>	<u>Sample Types</u>
GWD	Groundwater collected after a period of dry weather (suffixes A, B and C represent bottles for different types of analyses; see Table 2)
GWW	Groundwater collected after a period of wet weather (suffixes A, B and C represent bottles for different types of analyses; see Table 2)
LD	Leachate from landfill collected after a period of dry weather (suffixes A to E represent bottles for different types of analyses; see Table 2)
LW	Leachate from landfill collected after a period of wet weather (suffixes A to E represent bottles for different types of analyses; see Table 2)
MS	Mussels ( <u>Mytilus edulis</u> )
SD	Sediment core (suffix A indicates 0 to 4" depth; B indicates center of core and C bottom of core except at Gould Island Electroplating site suffix B indicates 6" to 12" depth - the depths along the core included in the sample are shown in inches in ( ) following the sample type in Tables 4 to ?)
SL	Soil (suffixes A and B represent bottles for different types of analyses; see Table 2)
SWW	Surface water collected after a period of wet weather (suffixes A and B represent bottles for different types of analyses; see Table 2)

At the laboratory, the samples and Custody Sheets were transferred to the incoming sample log-in room and the person receiving the sample signed the Custody Sheets. The samples were then logged in by the Sample Custodian.

Each analyst who worked on a sample signed the corresponding Laboratory Request/Custody Sheet and maintained responsibility for the sample until the next analyst worked on the sample. This procedure was monitored by the Sample Custodian. Upon completion of the analyses, completed results, analyst's initials, date of analysis, notebook and page numbers were recorded on Results of Analyses Sheets which were then attached to the Laboratory Services Request/Custody Sheet and given to the Sample Custodian for review. After review of the data, the results were organized on a computer and archived.

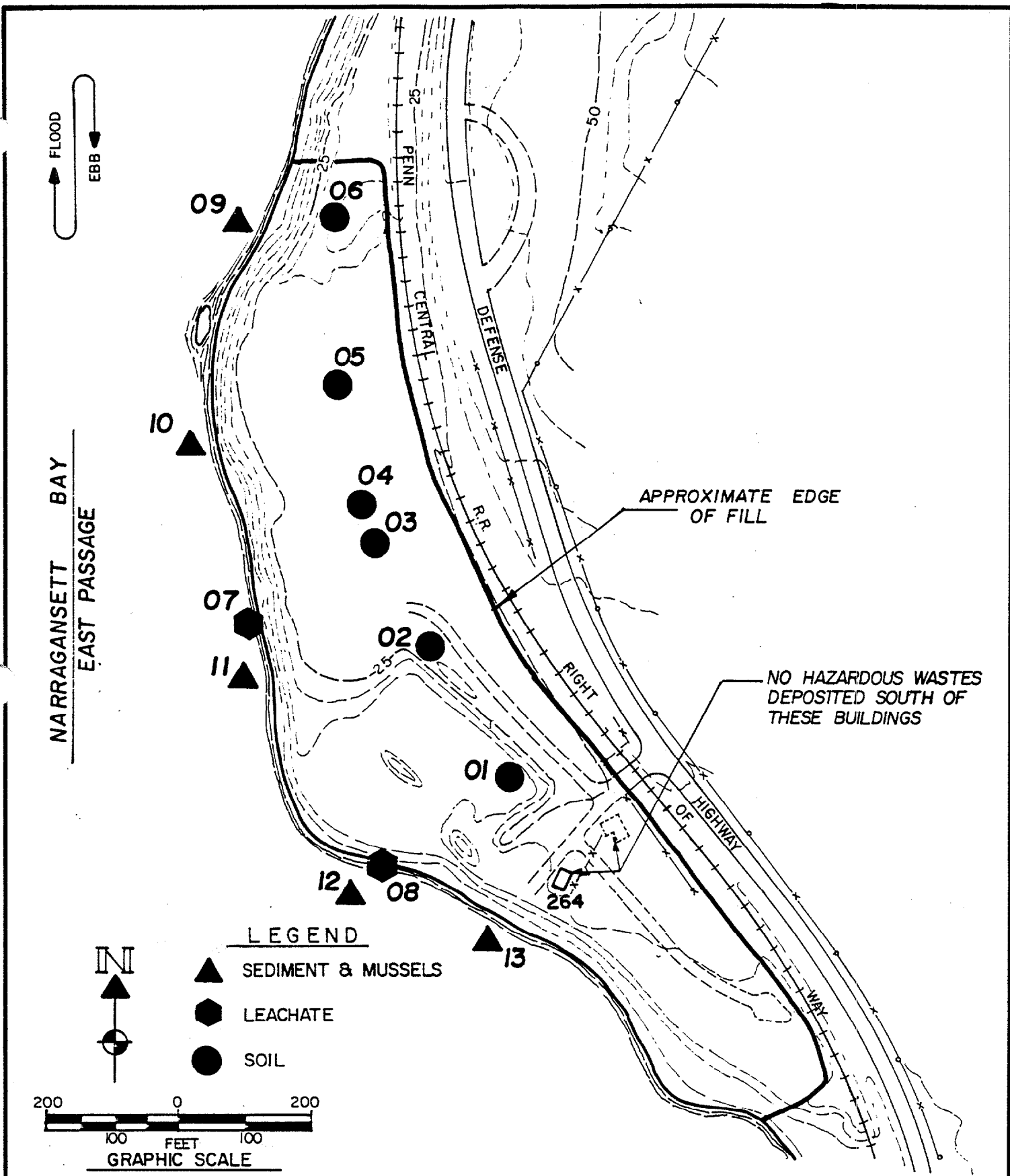
The samples were stored (or preserved if not already preserved) as dictated by sample type, which was the responsibility of the Sample Custodian. While samples were "work-in-progress" they were stored on the Sample Holding Shelves or the freezer or refrigerator (as required). This was noted on the Laboratory Services Request/Custody sheet for expeditious sample location by the next analyst. Completed samples were placed on the thirty day holding shelves and then transferred to the sample storage trailer for holding for an indefinite period.

#### 10. McAllister Point Landfill Samples

The samples collected in the verification step at the McAllister Point Landfill (Site No. 01) are listed in Table 4. The locations of the sample collection points are shown on Figure No. 3. The principal areas of interest for purposes of the sampling program in the verification step were:

- a. The marine environment at and near the shoreline of the landfill.
- b. The surface soils on the site.
- c. The leachate discharges from the site.





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# McALLISTER POINT LANDFILL SITE NO 01 VERIFICATION SAMPLING POINTS



York Wastewater Consultants, Inc.  
Stamford, Connecticut



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FEB. 28, 1984  
REVISED MAY 8, 1984

FIG. NO. 3

TABLE 4  
 SAMPLES COLLECTED - VERIFICATION STEP  
 SITE NO. 01 - McALLISTER POINT LANDFILL

<u>NO.</u>	<u>STA</u>	<u>TYPE</u>	<u>TIME</u>	<u>ANALYSIS FOR</u>
11-28-83				
8600	01	Soil	2:55 P.M.	*
8601	01	Soil	2:55	**
8602	02	Soil	3:00	*
8603	02	Soil	3:00	**
8604	03	Soil	3:05	*
8605	03	Soil	3:05	**
8606	04	Soil	3:10	*
8607	04	Soil	3:10	**
8608	05	Soil	3:15	*
8609	05	Soil	3:15	**
8610	06	Soil	3:20	*
8611	06	Soil	3:20	**
11-29-83				
8612	08	Leachate-Wet Weather	10:00 A.M.	PP-Vol. Org.
8613	08	Leachate-Wet Weather	10:00	PP-Acid & B/N Ext.
8614	08	Leachate-Wet Weather	10:00	PP-Metalst
8615	08	Leachate-Wet Weather	10:00	PP-CN
8616	08	Leachate-Wet Weather	10:00	PP-Phenols
8617	07	Leachate-Wet Weather	10:30	PP-Vol. Org.
8618	07	Leachate-Wet Weather	10:30	PP-Acid & B/N Ext.
8619	07	Leachate-Wet Weather	10:30	PP-Metalst
8620	07	Leachate-Wet Weather	10:30	PP-CN
8621	07	Leachate-Wet Weather	10:30	PP-Phenols
8622	09	Mussels	10:00	PCB, Metals
8623	10	Mussels	10:00	PCB, Metals
8624	11	Mussels	10:30	PCB, Metals
8625	12	Mussels	11:00	PCB, Metals
8626	13	Mussels	11:30	††
8627	09	Sediment (0-4)	10:15	PCB, Metals
8628	10	Sediment (0-4)	10:30	PCB, Metals
8629	11	Sediment (0-4)	10:45	PCB, Metals
8630	12	Sediment (0-4)	11:00	PCB, Metals
8631	13	Sediment (0-4)	11:15	PCB, Metals
11-30-83				
8632	13	Mussels	9:30 A.M.	††
8633	08	Leachate-Dry Weather	9:30	PP-Vol. Org.
8634	08	Leachate-Dry Weather	9:30	PP-Acid & B/N Ext.
8635	08	Leachate-Dry Weather	9:30	PP-Metalst
8636	08	Leachate-Dry Weather	9:30	PP-CN
8637	08	Leachate-Dry Weather	9:30	PP-Phenols

\*Composited in equal proportions and analyzed for priority pollutants (volatile organics only)

\*\*Composited in equal proportions and analyzed for priority pollutants (all except volatile organics)

†Metals = Cr, Cd, Pb, As, Hg, Se, Ag, Cu, Ba, Ni, Be, Sb, Sn

††Samples combined and analyzed for PCB, Metals

NOTE: PP signifies priority pollutants

The shoreline is almost 2000 feet long facing the East Passage of Narragansett Bay. The landfill is covered with soil but there are some exposed refuse deposits on the face of the landfill along the Bay. The shoreline is variable, ranging from shell and cobble beach areas to rip-rap, large rocks and exposed bedrock. A significant length of the beach has scattered deposits of metallic waste materials.

All five sediment samples (Station Nos. 09 to 13) were collected about 25 feet off-shore in one to three feet of water. All samples were surface sediments (0 to 4 inches deep). The deposits were very stony and samples of sediment were difficult to obtain.

All mussel samples were collected in the intertidal zone shoreward of the sediment sampling points (Station Nos. 09 to 13).

Soil samples were collected at six stations (Nos. 01 to 06) distributed along the approximate north-south central axis of the site. The points were selected at places where vegetation was absent. The six samples were composited in the laboratory for priority pollutant examination.

The two observable leachate discharges (Station Nos. 07 and 08) were sampled in wet weather immediately following a period of heavy rainfall. In addition, a sample of the southerly leachate discharge (Station 08) was repeated in dry weather.

## 11. Melville North Landfill Samples

The samples collected in the verification step at the Melville North Landfill (Site No. 02) are listed in Table 5. The locations of the sample collection points are shown on Figure No. 4. The principal areas of interest for purposes of the sampling program in the verification step were:

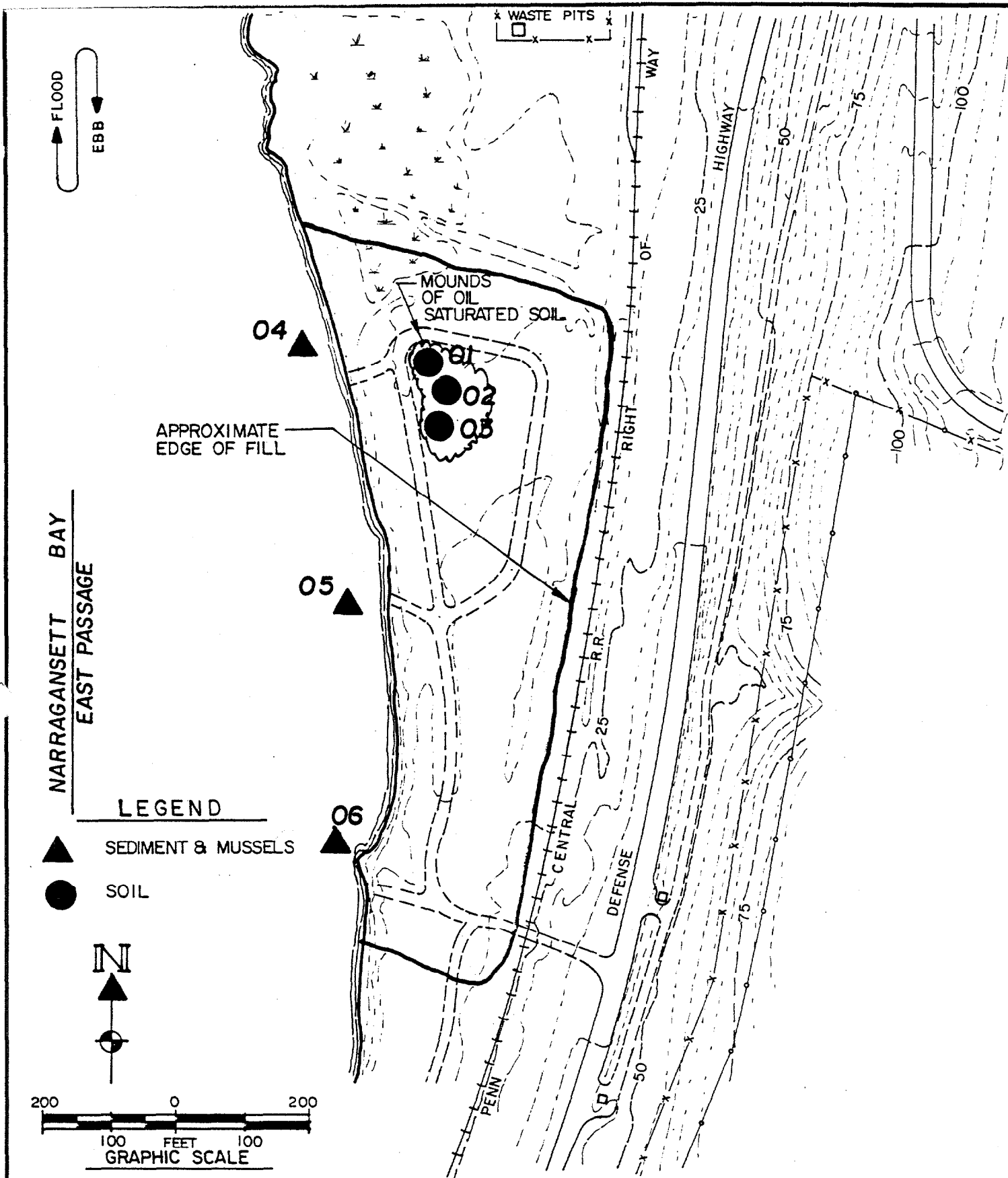
- a. The marine environment at and near the shoreline of the landfill.
- b. The surface soils on the site.

The shoreline is more than 1000 feet long facing the East Passage of Narragansett Bay. The landfill is covered with soil but there are some exposed piles of soil suspected to contain oils. The shoreline has a cobble and shell beach with some large rock outcrops. .

The nine sediment samples were collected from Station Nos. 04 to 06 about 25 feet off-shore in one to three feet of water. The deposits were predominantly silt and sand and were penetrable with the hand coring equipment. The three surface sediment samples (0-4 inches) were analyzed as indicated in Table 5, but the other samples (at depths up to 30 inches) were reserved for future use if required.

All mussel samples were collected in the intertidal zone shoreward of the sediment sampling stations (Nos. 04 to 06).

Three soil samples were collected at points distributed along piles of soil where suspected oily deposits are visible (Station Nos. 01 to 03). The three samples were composited in the laboratory for examination for lead, PCB and petroleum based hydrocarbons.



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# **MELVILLE NORTH LANDFILL SITE NO 02 VERIFICATION SAMPLING POINTS**



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FEB. 28, 1984

**FIG. NO. 4**

TABLE 5  
SAMPLES COLLECTED - VERIFICATION STEP  
SITE NO. 02 - MELVILLE NORTH LANDFILL

<u>NO.</u>	<u>STA</u>	<u>TYPE</u>	<u>TIME</u>	<u>ANALYSIS FOR</u>
			11-28-83	
8660	01	Soil	3:55 P.M.	*
8661	02	Soil	4:00	*
8662	03	Soil	4:05	*
			11-29-83	
8663	06	Mussels	8:45 A.M.	PCB, Metals†
8664	05	Mussels	9:15	PCB, Metals
8665	04	Mussels	9:30	PCB, Metals
8666	04	Sediment (0-4)	8:40	PCB, Metals
8667	04	Sediment (8-12)	8:40	**
8668	04	Sediment (15-18)	8:40	**
8669	05	Sediment (0-4)	9:15	PCB, Metals
8670	05	Sediment (12-16)	9:15	**
8671	05	Sediment (27-30)	9:15	**
8672	06	Sediment (0-4)	9:30	PCB, Metals
8673	06	Sediment (10-14)	9:30	**
8674	06	Sediment (20-24)	9:30	**

\*Samples were composited into one sample and analyzed for lead, PCB and petroleum based hydrocarbons.

\*\*Samples not analyzed in the verification stage.

†Metals = Cr, Cd, Pb, As, Hg, Se, Ag, Cu, Ba, Ni, Be, Sb, Sn.

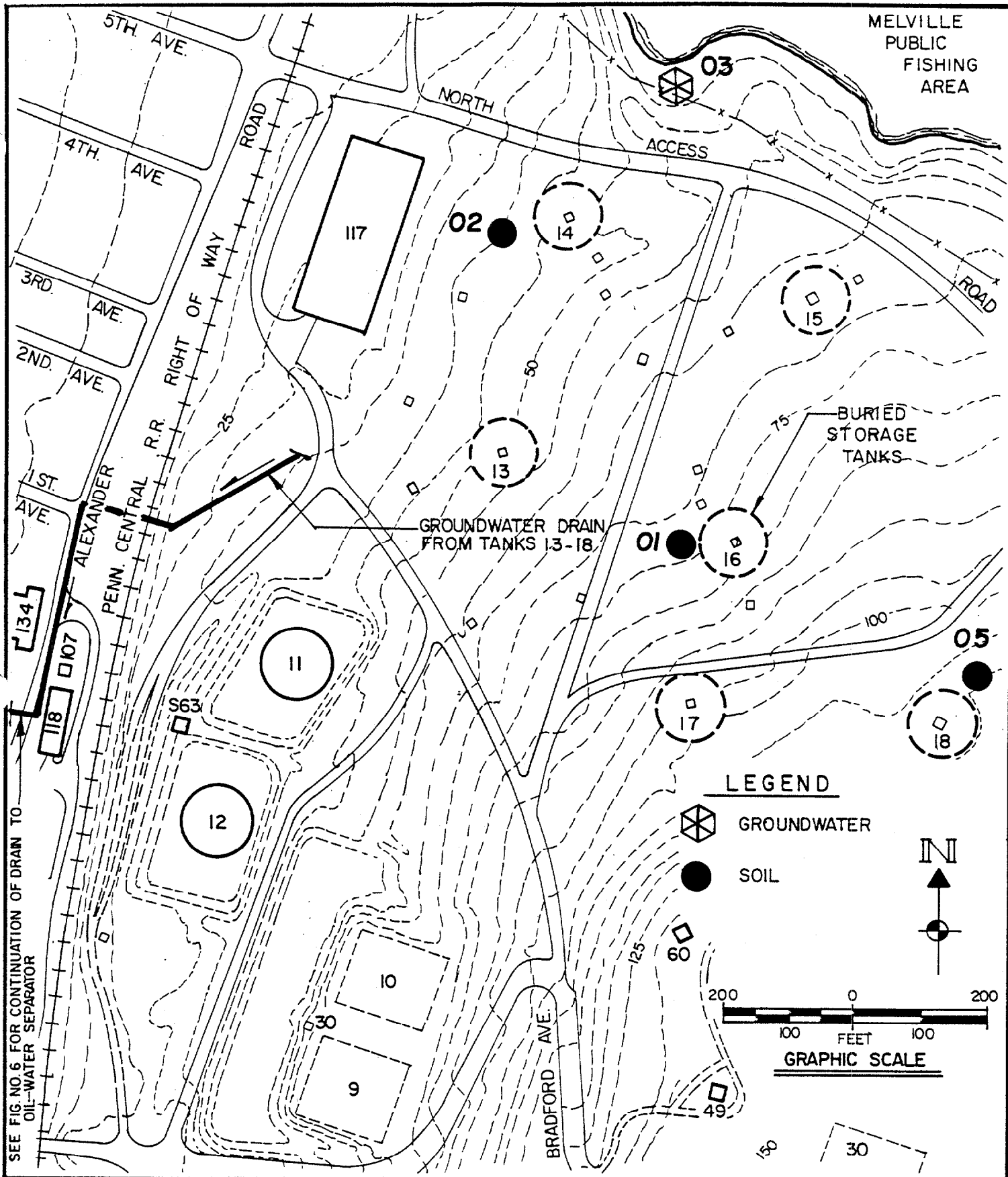
## 12. Tank Farm One Samples

The samples collected in the verification step at Tank Farm One (Site No. 07) are listed in Table 6. The locations of the sample collection points are shown on Figure Nos. 5 and 6. The principal areas of interest for purposes of the sampling program in the verification step were:

- a. The groundwater at the site.
- b. The soils on the site.

The groundwater samples were collected at two stations (Nos. 03 and 04) under both wet and dry weather conditions. One pair of the samples was from a groundwater observation well (Station No. 03) near the Melville Public Fishing Area north of Tank Farm One. The other pair was from a bypass around an oil - water separator (Station No. 04) on a system which drains groundwater from around the storage tanks at Tank Farm One.

The soil samples were collected from a depth of three feet at three locations (Station Nos. 01, 02 and 05) where sludges from storage tanks had been disposed of in pits and covered. The three samples were composited in the laboratory prior to examination.



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# TANK FARM ONE SITE NO 07 VERIFICATION SAMPLING POINTS



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FIG. NO. 5



CHAMBER 163

NOTE: THIS DRAIN COLLECTS GROUNDWATER FROM THE VICINITY OF BURIED TANKS NUMBERED 13 TO 18 (SEE FIG. NO. 5 FOR CONTINUATION)

SLAB TO BLDG 65

6" AC. B.S. & W.

QUARTERS D

OIL-WATER SEPARATOR

NOTE:  
THESE BYPASS LINES WERE USED  
DURING SAMPLING AT STATION 04

HOLDING BASIN

04

OIL-WATER SEPARATOR

M.H.

ROAD

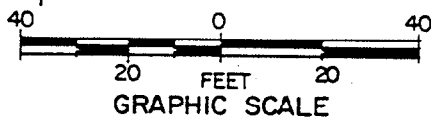
ALEXANDER

N

LEGEND



GROUNDWATER



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TANK FARM ONE - OIL-WATER SEPARATOR  
SITE NO 07  
VERIFICATION SAMPLING POINTS



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FIG. NO. 6

TABLE 6  
SAMPLES COLLECTED - VERIFICATION STEP ONE

SITE NO. 07 - TANK FARM 1

<u>NO.</u>	<u>STA</u>	<u>TYPE</u>	<u>TIME</u>	<u>ANALYSIS FOR</u>
			11-28-83	
8685	03	Groundwater-Dry Weather	11:30 A.M.	BTX
8686	03	Groundwater-Dry Weather	11:30	PBHC*
8687	03	Groundwater-Dry Weather	11:30	Lead
8688	04	Groundwater-Dry Weather	11:55	BTX
8689	04	Groundwater-Dry Weather	11:55	PBHC
8690	04	Groundwater-Dry Weather	11:55	Lead
			11-29-83	
8691	04	Groundwater-Wet Weather	1:55 P.M.	BTX
8692	04	Groundwater-Wet Weather	1:55	PBHC
8693	04	Groundwater-Wet Weather	1:55	Lead
8694	03	Groundwater-Wet Weather	2:25	BTX
8695	03	Groundwater-Wet Weather	2:25	PBHC
8696	03	Groundwater-Wet Weather	2:25	Lead
			11-30-83	
8697	05	Soil	7:45 A.M.	**
8698	02	Soil	8:00	**
8699	01	Soil	8:15	**

\*Petroleum Based Hydrocarbons.

\*\*Samples analyzed for lead and oil and grease.

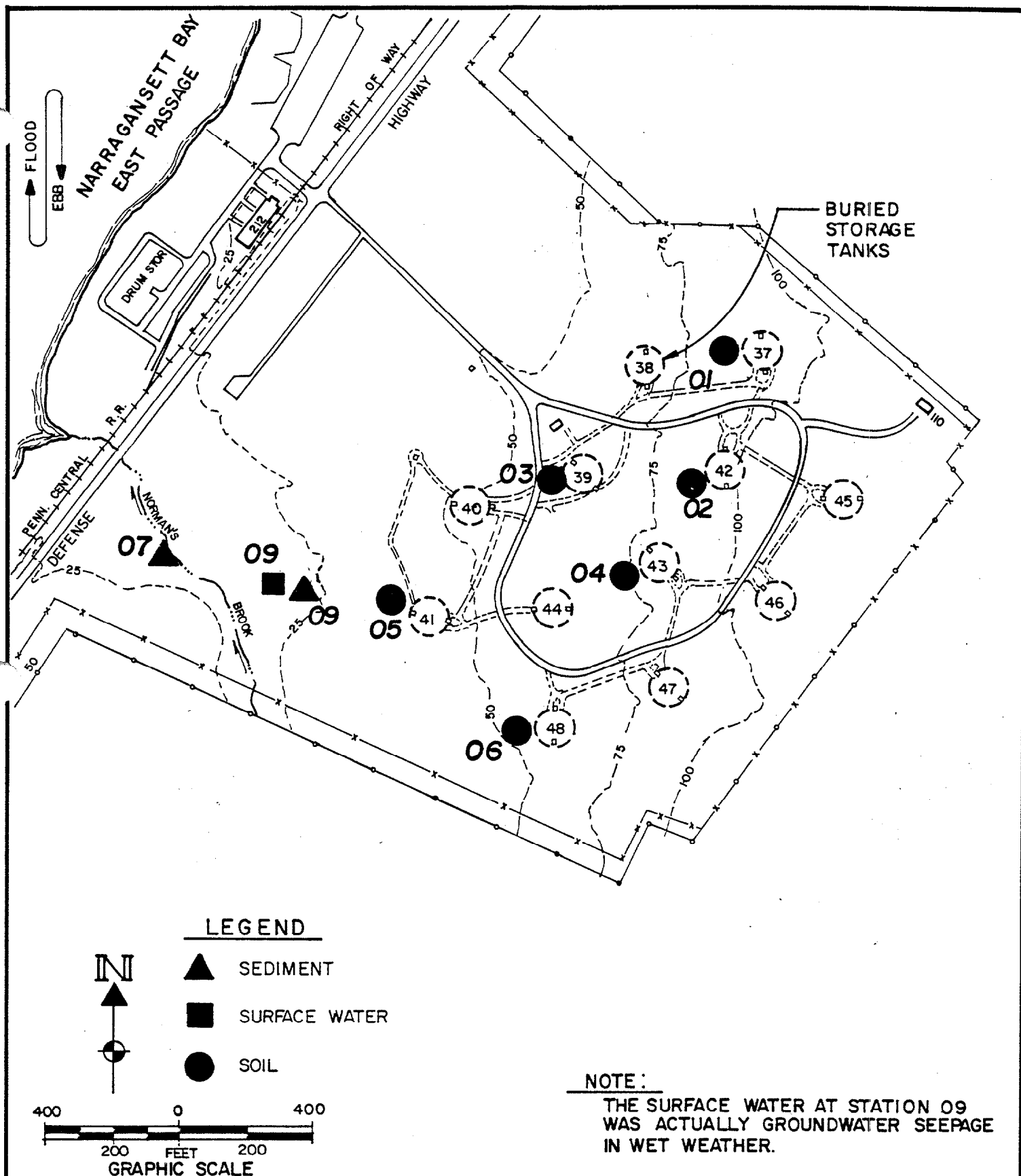
### 13. Tank Farm Four Samples

The samples collected in the verification step at Tank Farm Four (Site No. 12) are listed in Table 7. The locations of the sample collection points are shown on Figure No. 7. The principal areas of interest for purposes of the sampling program in the verification step were:

- a. Groundwater at the site.
- b. The soils on the site.

There were no readily available ground water observation points or sample points on or near the site. However, the sample of surface water collected from a swale (Station No. 09) several hours after period of rainfall may be considered to be representative of shallow groundwater since most of the contributory flow was observed to be seepage out of the ground rather than overland runoff.

The soil samples were collected from a depth of three feet at six locations (Station Nos. 01 to 06) where sludges from storage tanks were suspected to have been disposed of in pits and covered. The six soil samples were composited in the laboratory prior to examination.



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TANK FARM FOUR  
SITE NO 12  
VERIFICATION SAMPLING POINTS



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FIG. NO. 7

TABLE 7  
SAMPLES COLLECTED - VERIFICATION STEP

SITE NO. 12 - TANK FARM FOUR

<u>NO.</u>	<u>STA</u>	<u>TYPE</u>	<u>TIME</u>	<u>ANALYSIS FOR</u>
8710	07	Sediment (0-4)	11-28-83 3:45 P.M.	*
8711	09	Sediment (0-4)	11-29-83 3:15 P.M.	Lead, PBHC**
8712	09	Surface Water-Wet Weather	3:10	PBHC
8713	09	Surface Water-Wet Weather	3:10	Lead
8714	01	Soil	2:15	†
8715	02	Soil	2:30	†
8716	03	Soil	2:45	†
8717	04	Soil	3:00	†
8718	05	Soil	3:15	†
8719	06	Soil	3:30	†

\*Sample not analyzed in the verification stage.

\*\*Petroleum Based Hydrocarbons

†Samples were composited into one sample and analyzed for lead and oil and grease

#### 14. Gould Island Disposal Area Samples

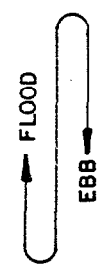
The samples collected in the verification step at the Gould Island Disposal Area (Site No. 14) are listed in Table 8. The locations of the sample collection points are shown on Figure No. 8. The principal areas of interest for purposes of the sampling program in the verification step were in the marine environment at and near the shoreline of the disposal area.

The shoreline is about 300 feet long facing the East Passage of Narragansett Bay. The landfill is covered with soil but there are some exposed deposits on the face of the fill area. The shoreline has a cobble and shell beach with some large rock outcrops and scattered deposits of metallic and other waste materials.

All three sediment samples (Station Nos. 01 to 03) were collected about 25 feet off-shore in one to three feet of water. All samples were surface sediments (0 to 4 inches deep). The deposits were very stony and samples of sediment were difficult to obtain.

All mussel samples were collected in the intertidal zone shoreward of the sediment sampling points (Station Nos. 01 to 03).

SEE FIG. NO. 9 FOR  
NORTH HALF OF ISLAND  
(SITE NO 17)

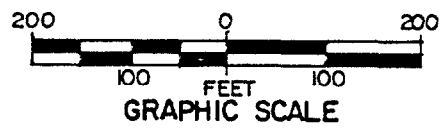


01 ▲  
02 ▲  
03 ▲

GOULD ISLAND  
DISPOSAL AREA

LEGEND

▲ SEDIMENT & MUSSELS



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GOULD ISLAND DISPOSAL AREA  
SITE NO 14  
VERIFICATION SAMPLING POINTS



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FEB. 28, 1984

FIG. NO. 8

#### 15. Gould Island Electroplating Shop Samples

The samples collected in the verification step at the Gould Island Electroplating Shop (Site No. 17) are listed in Table 9. The locations of the sample collection points are shown on Figure No. 9. The principal areas of interest for purposes of the sampling program in the verification step were in the marine environment at and near the shoreline.

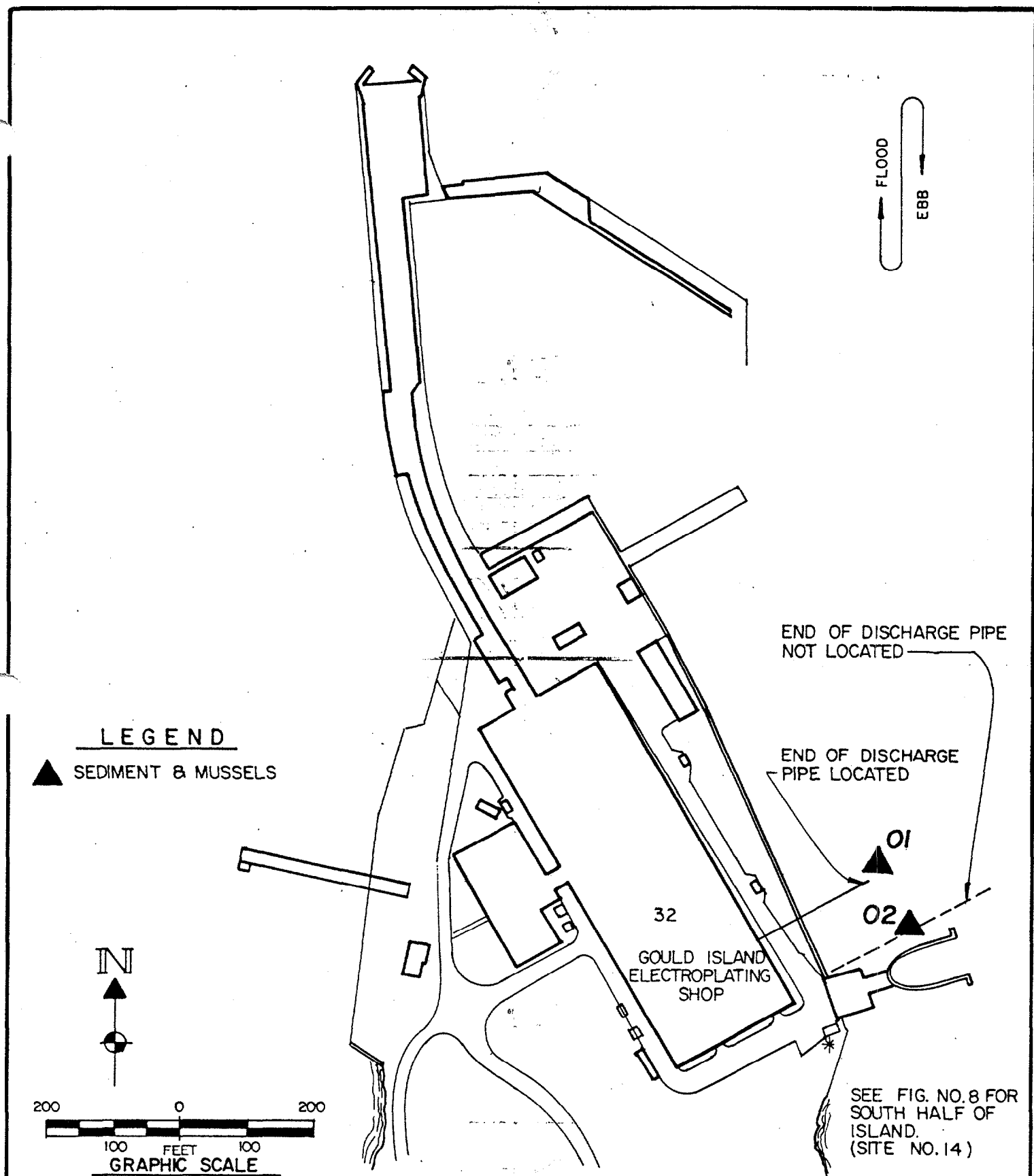
The sediment samples were collected from Station Nos. 01 and 02 about 25 feet off-shore in one to three feet of water. The deposits were predominantly stony silt and sand and were penetrated with the hand coring equipment with great difficulty. The two surface sediment samples (0-4 inches) were analyzed as indicated in Table 9, but the other sample (at a depth of 6-12 inches) was reserved for future use if required.

All mussel samples were collected in the intertidal zone shoreward of the sediment sampling stations (Nos. 01 and 02).

Station No. 01 was located beyond the end of a pipe which may have carried electroplating wastewater discharges when the facility was active. The end of a similar pipe near Station No. 02 could not be located since the pipe was covered with weeds and silt.

B-19 Missing  
Table-8





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**GOULD ISLAND ELECTROPLATING SHOP  
SITE NO 17  
VERIFICATION SAMPLING POINTS**



York Wastewater Consultants, Inc.  
Stamford, Connecticut



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**FEB. 28, 1984**

**FIG. NO. 9**

TABLE 9  
SAMPLES COLLECTED - VERIFICATION STEP

SITE NO. 17 - GOULD ISLAND ELECTROPLATING SHOP

<u>NO.</u>	<u>STA</u>	<u>TYPE</u>	<u>TIME</u>	<u>ANALYSIS FOR</u>
			12-1-83	
8750	02	Sediment (0-4)	10:00 A.M.	Cyanide, Metals*
8751	01	Sediment (0-4)	10:30	Cyanide, Metals
8752*	01	Sediment (6-12)	10:30	**
8753	02	Mussels	10:00	Metals
8754	01	Mussels	10:30	Metals

\*Metals = Cr, Cd, Pb, Hg, Ag, Cu, Ni

\*\*Sample not analyzed in the verification stage

TABLE 9  
SAMPLES COLLECTED - VERIFICATION STEP  
SITE NO. 17 - GOULD ISLAND ELECTROPLATING SHOP

## 16. Control Samples

The control samples collected in the verification step (Station Nos. N1 and N2) are listed in Table 10. The locations of the sampling points are shown in Figure No. 2. The principal purpose of the control sampling program in the verification step was to obtain data on the marine environment at and near the shoreline of areas not affected by any of the six sites.

The philosophy used in selecting the control stations was that they should offer similar abiotic factors and should not be close to any known point sources of pollution, but should be close enough to the six sites (but outside the direct influence of the sites) under investigation so that biota and sediments collected at the control stations will have been exposed to similar estuarine conditions as those collected close to the six sites. The differences in analytical results between control samples and site specific samples will give a general indication of the environmental impact of the six sites. It is obvious that all samples, including controls, will be subject to Bay pollution loads. By locating the site specific sample stations very close to the respective sites, the highest probability of detecting the potential pollutants from that site was achieved. By locating the control stations near the six sites, a comparison can be made between the site specific samples and the control samples with similar exposure to Bay pollutants but without direct influence of the six sites. If the control stations were located outside the Bay, or in very different abiotic environments, such comparisons would not be meaningful because important abiotic factors would not be consistent and the level of pollutants detected could not be evaluated against other similar areas of the Bay.

TABLE 10  
CONTROL SAMPLES COLLECTED - VERIFICATION STEP

<u>NO.</u>	<u>STA</u>	<u>TYPE</u>	<u>TIME</u>	<u>ANALYSIS FOR</u>
			11-30-83	
8765	N1	Sediment (0-4)	9:30 A.M.	Cyanide, PCB, Metals*
8766	N1	Mussels	9:30	PCB, Metals
8775	N2	Mussels	11:10	PCB, Metals
8776	N2	Sediment (0-4)	11:20	Cyanide, PCB, Metals

\*Metals = Cr, Cd, Pb, As, Hg, Se, Ag, Cu, Ba, Ni, Be, Sb, Sn.

B-23

11-30-83  
9:30  
9:30  
11:10  
11:20

Se, Ag, Cu

The control samples were collected at two sites in East Passage of Narragansett Bay - N1 north of Site 02 and N2 south of Site 14. The shoreline conditions were very similar to those at most of the site specific stations, the only exception being the Melville North Landfill where softer sediments were found.

... at ...  
... 02 and N2 ...  
... at most ...  
... landfill ...

## C. LABORATORY ANALYSES

### 1. Basic Analytical References

Where applicable, all methods were conducted in accordance with the following manuals or references:

- a. Chemical Analysis of Water and Wastes, EPA-600/4-79-020, 1979;
- b. Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, EPA-600/4-82-057, 1982;
- c. Procedures for Handling and Chemical Analysis of Sediment and Water Samples, EPA/CE81-1, 1981;
- d. Test Methods for Evaluating Solid Waste, EPA SW-846, 1980;
- e. Chemistry Laboratory Manual for Bottom Sediments and Elutriate Testing, EPA 905/4-79-014, PB 294, 1979;
- f. Standard Methods for the Examination of Water and Wastewater, 15th Edition, 1980;
- g. Methods for Analysis of Fish for PCB's, U.S. EPA, Northrup Repository.

The following sections present brief abstracts of the analytical methods used for the various types of analyses performed in this project.

### 2. Priority Pollutant Analyses

#### a. Miscellaneous

Both water and sediment samples were analyzed for priority pollutants. Metal concentrations were determined using the previously referenced methods.

Cyanides were analyzed according to Standard Methods for the Examination of Water and Wastewater, 15th Edition; APHA-AWWA-WPCF and Methods for Analysis of Water and Wastes, U.S. EPA 600/4-79-020.

Briefly, the cyanides were distilled from acid solution and absorbed into dilute sodium hydroxide. Cyanide was then determined colorimetrically using the pyridine-barbituric acid method.

Phenols were determined colorimetrically via the 4-aminoantipyrine method after distillation. References can be found in the previously cited works and in Procedures for Handling and Chemical Analysis of Sediment and Water Samples, U.S. EPA, May 1981.

#### b. Volatiles

Water samples for volatile organics (purgeables) were analyzed using GC/MS/DS according to EPA Method 624 for Purgeable Organics. The method uses the purge and trap technique to strip the volatiles from the water which are then adsorbed onto a support which is then thermally desorbed into the GC/MS/DS. The instrumentation used was a Tekmar Model LSC-2 Liquid Sample concentrator interfaced with a Hewlett-Packard 5995B GC/MS/DS.

Soil samples were analyzed using the dynamic headspace purging technique in accordance with reference (a) cited above. A sample is weighed into a 40 ml septum vial. The vial is then attached to the LSC-2 and then purged at 80°C. Volatiles are then identified and quantified by GC/MS/DS.

#### c. Base/Neutral and Acidic Organics

The remaining organic priority pollutants (Base/Neutrals, Acids) were analyzed according to EPA Method 625. For water samples the water is extracted with methylene chloride, the extract dried and then concentrated to 1 ml. Samples are then injected into the GC/MS/DS to identify and quantitate the target compounds present.

Soil samples were air dried and then soxhlet extracted for 16 hours using equal volumes of acetone and hexane. The solvent was then concentrated to 1 ml and analyzed by GC/MS/DS.

### 3. Metals Analyses

All metal concentrations were determined by flame atomic absorption spectroscopy with the exception of arsenic, mercury and selenium. Arsenic and

selenium were determined via the hydride generation method while mercury was determined by the cold vapor technique.

Deuterium arc background correction was also used for arsenic and selenium.

Preliminary acid digestion and concentration steps varied depending on the types of samples analyzed. A brief description of the various methods (excluding mercury) is as follows:

a. Water Samples

All water samples were acidified with nitric acid and hydrochloric acid (except when silver was requested) and gently evaporated to ensure destruction of organic matter and to concentrate the sample.

After digestion, the samples were diluted volumetrically and the metal concentrations determined as previously stated.

b. Soils and Sediments

Samples were initially air dried and then weighed out into tared beakers. Samples were digested with nitric acid and hydrogen peroxide to ensure destruction of all organic matter.

After digestion, the samples were filtered and diluted volumetrically. Metals were then determined by atomic absorption.

c. Biological Samples

The mussel samples were gathered and placed in a cooler and maintained at 4°C until arrival at the laboratory. Immediately thereafter, the samples were transferred to a freezer and maintained at -15°C until analysis. Depuration of the samples was not carried out in this study.

It is noted that a number of the mussels died during storage as indicated by relaxation of the adductor muscle. These particular animals were not analyzed. The effects of the aforementioned preservation techniques on the data for mussels is not clearly defineable; specific attention



is directed, however, to the possibility that some of the contaminants may have been lost from the samples during preservation as indicated by the death of some of the animals. In our opinion, these losses, if in fact they occurred, would have applied to both control samples and to site specific samples and, consequently, would not affect the conclusions drawn on any of the sites investigated.

The analysis for metals was conducted using standard procedures. The procedure involved air-drying the samples followed by cryogenic homogenation of the tissue. Each sample was comprised of 10-15 mussels. The resulting prepared samples were then acid digested with a mixture of nitric acid and hydrogen peroxide, followed by perchloric acid to complete destruction and solubilization. The specific elements were then analyzed using atomic absorption techniques.

#### d. Mercury

All samples, except tissue samples, were analyzed using the following procedure:

Samples were weighed (solids) or measured (liquids) into 300 ml BOD bottles. To these were added nitric acid, sulfuric acid, potassium permanganate and potassium persulfate. After autoclaving, the samples were run via the cold vapor procedure.

The same procedure was also used for tissues, except that an aliquot of the digestate following perchloric acid oxidation was used.

#### 4. Polychlorinated Biphenyls Analyses

A brief abstract of the methods used to determine the PCB content of the various types of samples is as follows:

##### a. Water Samples

Water samples were analyzed according to method reference (b) cited above, EPA Method 608, Organochlorine Pesticides and PCB's. The sample was

extracted with methylene chloride, the extract dried and concentrated to a volume less than 10 mls. Samples were then run via gas chromatography using an electron capture detector ( $\text{Ni}^{63}$ ). Cleanup techniques were used as required. These techniques included florisil and/or mercury treatment.

#### b. Soil and Sediment Samples

Soil and sediment samples were analyzed according to Procedures for Handling and Chemical Analysis of Sediment and Water Samples, U.S. EPA, May, 1981 and Chemistry Laboratory Manual for Bottom Sediments and Elutriate Testing, U.S. EPA, March, 1979.

The samples were initially air dried and then soxhlet extracted for 16 hours using equal volumes of acetone/hexane. The volume was then concentrated to less than 10 mls and analyzed via gas chromatography using an electron capture detector ( $\text{Ni}^{63}$ ). Cleanup techniques were used as required.

#### c. Biological Samples

The comments made above in the discussion of metals analyses concerning sample preservation may also apply to the PCB determinations although there is even less evidence of potential loss of PCB than for metals.

The analysis for PCBs was conducted using procedures supplied by the Northrup Repository of the United States Environmental Protection Agency. The entire mussel tissue was analyzed on a dry-weight basis subsequent to air drying (ambient temperature of 65°F) and cryogenic homogenation. Each sample was comprised of 10-20 mussels.

The procedure involved the cryogenic homogenation of the air-dried tissue, followed by extraction with pesticide quality hexane. The extract was concentrated to less than 10 mls, and the PCBs (if present) were extracted by liquid-liquid partitioning using acetonitrile. The PCBs (if present) were then re-extracted back into hexane and concentrated to 1 ml.

The extract was further treated with florisil to remove any other interferences. The final concentrate was then analyzed using gas chromatography with electron capture detection.

## 5. Miscellaneous Analyses

### a. Oil and Grease

Samples for oil and grease were analyzed according to Standard Methods and Procedures for Handling and Chemical Analysis of Sediment and Water Samples. Basically, the procedure calls for extraction of the sample with Freon (separatory funnel extraction for water samples and Soxhlet extraction for soil samples) followed by evaporation of the Freon and weighing of the residue.

### b. Petroleum Hydrocarbons

Petroleum hydrocarbons are determined by the same method as oil and grease, except that prior to evaporation of the Freon, silica gel is added to adsorb fatty acids (polar materials). The solution is filtered, the Freon evaporated and the residue weighed.

## 6. Quality Control/Quality Assurance

In order to verify the overall accuracy and precision of the methods, various quality control and quality assurance procedures were followed in each aspect of the laboratory routine. The specific procedures used are delineated in the following paragraphs. A summary of the QA/QC data can be found in Appendix D.

### a. Atomic Absorption Spectroscopy (Metals Determinations)

The most critical aspect of metals determination by atomic absorption spectroscopy (A.A.S.) is the quality of the standards used. As such, fresh standards were prepared for each metal analyzed from certified stock solutions<sup>1</sup>. Reagent grade chemicals were used in all analyses.

<sup>1</sup>Obtained from Scientific Products Division of American Hospital Supply Corporation.

Also laboratory standards and blanks were run through all of the digestion procedures and used to check recoveries and the technique of the analysts.

Calibration of the instrumentation was checked before and after each metal determination and recorded in laboratory notebooks. In addition, duplicates and referenced environmental standards were analyzed to indicate the precision of the methods used.

A summary of this data is included in Appendix D.

b. Gas Chromatography (Pesticides and PCB's)

Referenced U.S. EPA procedures were used in all gas chromatography analyses. Instrument calibration was checked each day at various concentrations in order to obtain a good linear working range. Gases and solvents used were of ultra high purity and commercial standards were obtained for calibration (see Appendix D).

Known environmental standards (obtained from Connecticut State Department of Health and U.S. EPA) were analyzed "blindly" to verify both analytical methods and accuracy. This data is summarized in Appendix D.

c. GC/MS Analysis

Samples for GC/MS analysis included volatile organics (EPA Method 624) and Base/Neutrals, Acids, and Pesticides (EPA Method 625). Initially, the instrument was calibrated at four levels for volatile organics and the samples analyzed. (Surrogate standards were added to each sample.) The same general calibration procedure was followed for the base/neutrals, acids and pesticides. Calibration was checked each day and internal standardization was used to quantify the compounds identified.

## 7. Results of Analytical Tests on Samples Collected

The samples listed in Tables 4 to 10 were analyzed and the results are shown in the laboratory reports in Appendix C. The results shown in Appendix C are also presented in tables in the text separately for each site in connection with the discussions of findings at each site.

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## D. FINDINGS AT SITE NO. 01 McALLISTER POINT LANDFILL

### 1. History of Waste Disposal

The history of waste disposal at this site was thoroughly covered in the IAS. The following discussion summarizes the background information contained in the IAS.

This landfill received all of the wastes generated at the Newport Naval complex from 1955 through the mid-1970's and is known to contain at least 200 gallons of PCB contaminated oil. Also in the landfill are spent acids, waste paints, solvents, and waste oils.

The operators of the landfill indicated that it was common practice for barrels filled with liquids to be brought to the landfill. These barrels contained paints, oils and other unidentifiable liquids. The barrels were crushed by the bulldozer operator before being covered. At least two transformers, each containing approximately 100 gallons of PCB contaminated oil, and at least 4 or 5 capacitors were disposed of in the landfill.

For the period 1955 through 1964, wastes were simply trucked to the site, spread out with a bulldozer, and then covered over. In 1965, an incinerator was built at the landfill. From 1965 through 1970-71, some 98 percent of all the wastes were burned before being disposed of in the landfill. The incinerator was closed about 1970 because of the air pollution problems. During the remaining years that the site was operational, all wastes were again disposed of directly into the landfill.

The site is located along the shoreline of Narragansett Bay. Throughout the time period that the site was operational, the landfill was extended out into the bay using the wastes as fill material. No hazardous wastes were deposited on the southern end of site; that is, south of Building 264 (Figure 10). The site was subject to periodic flooding until the elevation of the site was

increased through additional filling. Even though the site is no longer subject to flooding, the base of the landfill has remained in hydrologic contact with the bay and the groundwater.

Operations at the site were discontinued in the mid-1970's. A final covering of soil three feet thick was placed over the NETC landfill following its closure.

## 2. Existing Site Conditions

The landfill is located along the shoreline of Narragansett Bay and encompasses approximately six acres. The site is located on land which is being excessed by the Navy. Various unvegetated bare areas are evident throughout the surface of the landfill. Surface runoff and groundwater from the landfill flow into Narragansett Bay. Two leachate streams are evident; the one located at Station 08 (see Figure No. 3) exhibits significant flow except at high tide while the one at Station 07 exhibits only slight flow in wet weather and no flow in dry weather. There is one area where water ponds on the surface in wet weather. There are some exposed waste deposits, particularly on the steep face of the fill in the vicinity of Station 07. The shoreline is littered with considerable amounts of metallic wastes, particularly south of Station 11.

## 3. Hydrogeological Data

The general hydrogeology of the NETC area was covered in the IAS. The following discussion summarizes conclusions drawn from the background hydrogeological data contained in the IAS.

The groundwater in areas close to the bay is often within just two or three feet of the surface. The groundwater moves in a westward direction and discharges into Narragansett Bay. This factor and the history of waste deposition into the low-lying coastal area indicate that the hydrogeology of the site is characterized by groundwater movement through the waste deposits in a general east to west direction. Some deviations from this general pattern may

be present due to the non-homogenous nature of the deposits. The groundwater is not being utilized at NETC. Any wells in the area are upgradient from the site and beyond its influence.

#### 4. Analytical Data on Samples Collected

The samples collected at the McAllister Point Landfill are summarized in Table 4 as previously discussed. The analyses were conducted for the parameters indicated in Table 4 and the detailed laboratory reports on the analyses are included in Appendix C. A summary of these results is presented in Table 11 for the sediment and mussel samples and in Tables 12 and 13 for the soil and leachate samples.

#### 5. Evaluation of Available Data

The analytical data on samples collected indicate that metals are accumulating in sediments and mussels near the McAllister Point Landfill. This judgment is based on comparison of the verification step sampling and analytical data with the control station data (see Table 11).

The surface layer of sediment at all five sampling points exhibited significantly high values of lead and copper; these were especially high at Station Nos. 12 and 13 which were closest to the larger of the two observed leachate discharges (Station No. 08). In addition, high values of nickel were evident at some of the stations, most notably Station Nos. 12 and 13. Slightly elevated values of chromium were also found at Station Nos. 12 and 13 (by comparison to the control stations) but these do not appear to be significant. No PCB contamination was found in any of the sediment samples.

Slightly elevated copper concentrations were found in mussels at Station Nos. 11, 12 and 13 by comparison to the controls. These do not appear to be significantly high, however. No other metals were found in the mussel samples. The PCB levels in mussels were the same as those found in the controls. See Section C for additional evaluation of analytical data on mussels.



TABLE 11  
SUMMARY OF SEDIMENT AND MUSSEL SAMPLE ANALYTICAL DATA  
SITE NO. 01 - McALLISTER POINT LANDFILL (NOV., 1983)  
(All results in ppm - dry weight basis)

Substrates and Parameters	Site Specific Station Numbers					Control Station Numbers	
	09	10	11	12	13	N1	N2
<u>SEDIMENT*:</u>							
PCB	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	7.5	7.0	6.3	17.5	14.8	11.5	8.0
Cadmium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Lead	70.0	77.5	57.5	900.	327.	27.5	6.8
Arsenic	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Selenium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Silver	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper	28.3	133.2	153.4	1455.	655.	18.3	10.3
Barium	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Nickel	19.3	22.0	32.8	64.0	55.5	21.3	11.3
Beryllium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Antimony	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Tin	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
<u>MUSSELS:</u>							
PCB	0.38	<0.01	0.29	0.33	0.29	0.36	0.37
Chromium	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Cadmium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Mercury	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Selenium	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Silver	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	6.0	6.4	9.2	12.2	28.3	7.2	4.3
Barium	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Nickel	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Beryllium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Antimony	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tin	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0

\*All sediment data is for the surface  
sediments at 0 to 4-inch depth.

TABLE 12  
SUMMARY OF ORGANICS AND PESTICIDES PRIORITY POLLUTANT ANALYTICAL  
DATA ON SOILS AND LEACHATE  
SITE NO. 01 - McALLISTER POINT LANDFILL (NOV., 1983)  
 (All results in in ug/l except soils in ppm (ug/kg) dry weight basis)

<u>Parameter</u>	<u>Station Numbers and Sample Types</u>			
	<u>01 to 06</u> <u>Soil</u> <u>Composite</u> <u>Sample</u>	<u>07</u> <u>Leachate</u> <u>Wet</u> <u>Weather</u>	<u>08</u> <u>Leachate</u> <u>Wet</u> <u>Weather</u>	<u>08</u> <u>Leachate</u> <u>Dry</u> <u>Weather</u>
VOLATILE ORGANICS				
Acrolein	<10	<100	<100	<100
Acrylonitrile	<10	<100	<100	<100
Ethylbenzene	<5	30	<10	<10
Toluene	<5	26	<10	<10
All Other Volatile Organics	<5	<10	<10	<10
BASE NEUTRAL EXTRACTABLE ORGANICS				
Benzo(GHI)Perylene	<1.25	<25	<25	<25
Dibenzo(A,H)Anthracene	<1.25	<25	<25	<25
Indeno(1,2,3-CD)Pyrene	<1.25	<25	<25	<25
All Other Base Neutral Extractable Organics	<0.5	<10	<10	<10
ACID EXTRACTABLE ORGANICS				
4,6-Dinitro-0-Cresol	<12.5	<250	<250	<250
2,4-Dinitrophenol	<12.5	<250	<250	<250
All Other Acid Extractable Organics	<1.25	<25	<25	<25
PESTICIDES	<0.5	<10	<10	<10

TABLE 13  
SUMMARY OF PCB, METALS, CYANIDE AND PHENOL PRIORITY POLLUTANT  
ANALYTICAL DATA ON SOILS AND LEACHATE  
SITE NO. 01 - McALLISTER POINT LANDFILL (NOV., 1983)  
(All results in in mg/l except soils in ppm dry weight basis)

Parameter	Station Numbers and Sample Types			
	01 to 06 Soil Composite Sample	07 Leachate Wet Weather	08 Leachate Wet Weather	08 Leachate Dry Weather
PCB's	<0.5	<0.010	<0.010	<0.010
Antimony	<0.5	<0.050	<0.050	<0.050
Arsenic	<0.2	<0.002	<0.002	<0.002
Beryllium	<0.05	<0.004	<0.004	<0.004
Cadmium	<0.05	0.028	0.058	0.054
Chromium	7.3	<0.020	0.028	0.032
Copper	13.5	<0.020	<0.020	<0.020
Lead	9.0	<0.040	<0.040	<0.040
Mercury	<0.02	<0.0002	<0.0002	<0.0002
Nickel	20.5	<0.020	<0.072	<0.090
Selenium	<0.2	<0.002	<0.002	<0.002
Silver	<0.5	<0.05	<0.05	<0.05
Thallium	<0.1	<0.01	<0.01	<0.01
Zinc	0.3	<0.01	<0.01	<0.01
Cyanides	0.047	0.017	0.876	0.097
Phenols	0.027	0.006	0.016	0.007
Chlorides			15,500	14,025

The priority pollutant examinations of the leachate samples indicated all priority pollutants to be below detection limits except for certain metals, cyanides and phenols. Low concentrations of ethylbenzene and toluene were found in one leachate sample. Tests for chlorides on leachate at Station 08 indicate brackish characteristics; it appears that bay water enters the fill and discharges at Station 08 on each tidal cycle.

The priority pollutant examination of the composite soil sample indicated no significantly high values. Except for chromium, copper, lead, nickel and zinc, all priority pollutants in soils were below detection limits.

#### 6. Location of Suspected Contaminant Sources

The sediment samples seem to indicate that certain metals are accumulating in the vicinity of Station Nos. 12 and 13 near the south end of the landfill. The pollutants are not being concentrated by the mussels to the same extent, although the copper concentrations in the mussels were substantially higher near the south end of the landfill than at other stations further north or at the control stations. There is no significant accumulation of metals in the soil cover.

The data seems to indicate that the landfill has caused or is continuing to cause metal deposition near Station Nos. 12 and 13. Further study is needed to determine if, in fact, the landfill is the source and, if so, if this is a continuing process or if the metals were deposited some time ago and further migration has ceased. Although the leachate discharge at Station No. 08 is suspect as a source because of its proximity to Station Nos. 12 and 13 the leachate samples did not exhibit high concentrations of contaminants.

#### 7. Plan of Action for Further Studies

Additional sampling and analysis is needed to determine if the landfill is releasing contaminants to Narragansett Bay and, if so, to identify the mechanism by which the contaminants are being released.

The additional sampling should include the sampling program shown in Table 14 and the sampling points shown on Figure 10. All samples should be analyzed for:

Cyanide	Chromium
Lead	Nickel
Copper	pH (groundwater)
	Chlorides (groundwater)

The studies should be limited to investigation of these parameters since there was no evidence of the presence of any other pollutants in the verification step samples. However, one set of groundwater samples should be analyzed for priority pollutants to confirm this. This is needed because if the leachate sample at Station 08 was actually diluted by heavy tidal intrusion as is suspected, then the priority pollutants found would have been highly diluted and not representative of actual leachate quality. The groundwater samples would be taken from wells located at the top of the bank. The depths of the wells would be determined at the time of drilling and would penetrate at least five feet into the groundwater/leachate level. Likewise, the elevation of screens would be determined depending on conditions encountered.

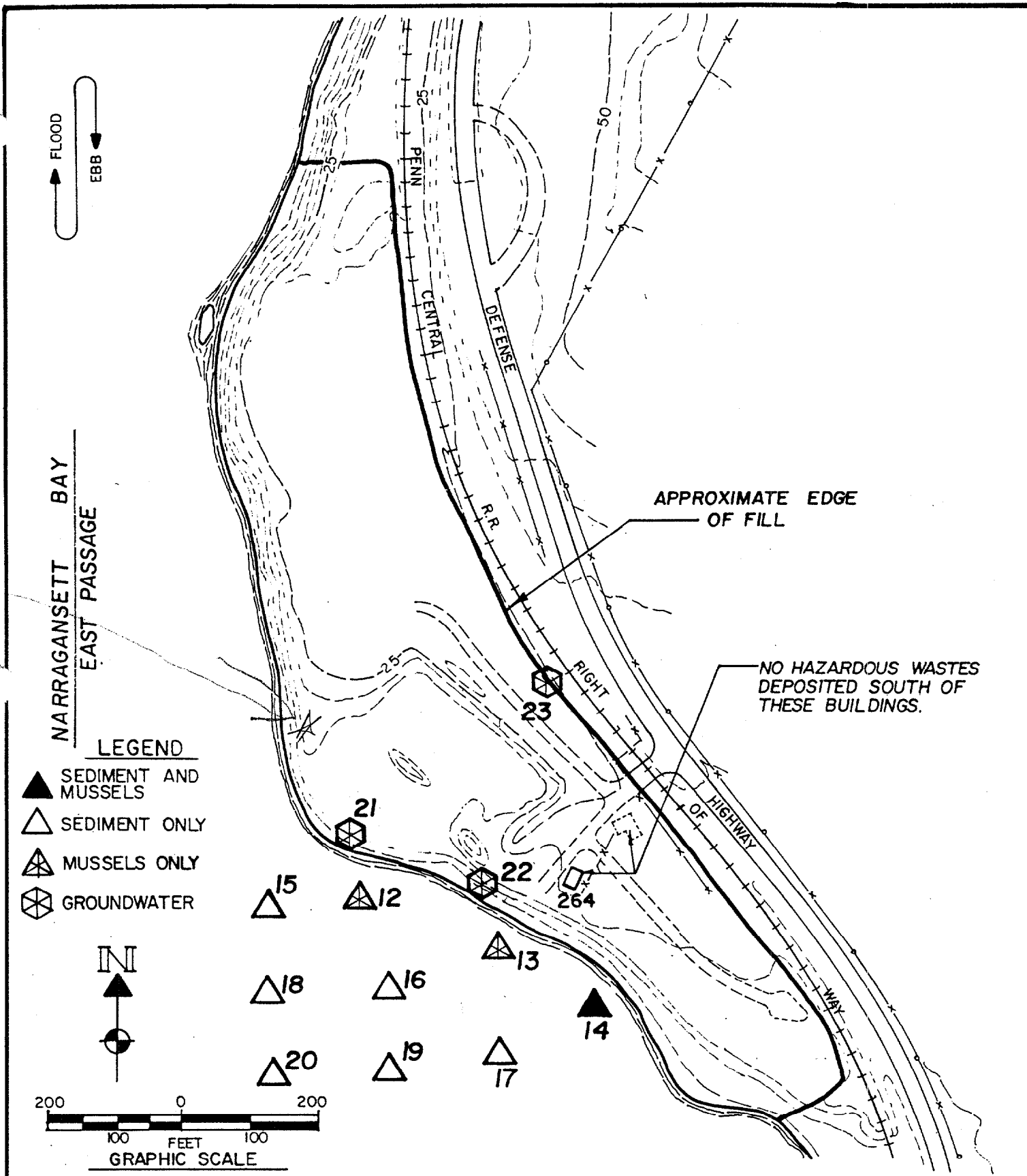
The groundwater samples will provide information on whether or not the landfill is releasing pollutants via subsurface movement (leachate release via groundwater travel into the bay).

The analytical data on the verification samples of soil and free leachate discharges indicate insignificant surface movement of contaminants; consequently, additional samples of soil and free leachate discharges are not warranted. The sediment samples will indicate the extent of existing metals deposits laterally to the south and vertically. The mussel samples will determine temporal variations in the effects on biota.

If low levels of contaminants are found in the groundwater samples at the stations shown on Figure No. 10, it can then be concluded from the hydro-geological data on the site conditions that the landfill is not contributing pollutants to the environment because, if the landfill is still contributing pollutants, the verification step analyses indicate that the only way this can happen is by way of the groundwater flow into the Bay.

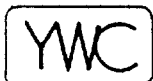
TABLE 14  
PROPOSED CHARACTERIZATION SAMPLES  
SITE NO. 01 - McALLISTER POINT LANDFILL

<u>Station Nos.</u>	<u>Sample Type</u>	<u>Number and Frequency of Samples at Each Station</u>
14-20	Sediment	1 sample at each of 3 depths (0, 1, 2 feet if conditions permit)
12 & 13	Mussels	1 sample from intertidal zone
21-23	Groundwater	4 samples one month apart



CONFIRMATION STUDY  
ON HAZARDOUS WASTE SITES  
NEWPORT NAVAL EDUCATION &  
TRAINING CENTER

McALLISTER POINT LANDFILL  
SITE NO 1  
PROPOSED CHARACTERIZATION SAMPLING POINTS



York Wastewater Consultants, Inc.  
Stamford, Connecticut



LOUREIRO ENGINEERING ASSOCIATES  
a professional corporation  
CONSULTING ENGINEERS

AVON, CT.

FEB. 28, 1984  
REVISED MAY 8, 1984

FIG. NO. 10



## E. FINDINGS AT SITE NO. 02 MELVILLE NORTH LANDFILL

### 1. History of Waste Disposal

The history of waste disposal at this site was thoroughly covered in the IAS. The following discussion summarizes the background information contained in the IAS.

This site was used as a landfill from World War II to 1955. Wastes disposed of in this landfill included mostly domestic type refuse and also spent acids, waste paints, solvents, waste oils (diesel, fuel and lube), and PCB's. Definitive information was not available on specific types of wastes received and the operating practices used. However, the IAS indicated that wastes disposed of in this landfill would have been similar to those discussed for the McAllister Point Landfill. Also, since the site is low lying and subject to periodic flooding, it can be safely presumed that wastes were deposited in wet conditions. It appears that there was some recent disposal of oil-soaked earth on one part of the site.

### 2. Existing Site Conditions

The site is situated in the Melville North area in a low-lying wetland type area along the shoreline of Narragansett Bay, as shown in Figure No. 4. Surface drainage and groundwater flow from the site is directly into the bay. The area is also subject to periodic flooding and lies within the 100 year flood plain. There are several areas which accumulate water and appear to be wet even in dry weather.

This site has been sold by the Government and is now in private ownership. It has an area of about 10 acres.

There are several mounds of oil-soaked soil which appeared to have been trucked to the site and dumped. These oil-contaminated mounds could be the oil sludge material obtained from the tank farms during tank cleaning operations, or the results of cleanup operations following oil spills.

### 3. Hydrogeological Data

The general hydrogeology of the NETC area was covered in the IAS. The following discussion summarizes conclusions drawn from the background hydrogeological data contained in the IAS.

The groundwater in areas close to the bay is often within just two or three feet of the surface. Due to the low-lying configuration of the site, groundwater levels are very shallow and in fact portions of the site, particularly on the north and east sides are very wet. The groundwater moves in a westward direction and discharges into Narragansett Bay. This factor and the history of waste deposition into the low-lying coastal area indicate that the hydrogeology of the site is characterized by groundwater movement through the waste deposits in a general east to west direction. Some deviations from this general pattern may be present due to the non-homogeneous nature of the deposits. There was no evidence of any direct leachate discharges into the Bay. The groundwater is not being utilized at NETC. Any wells in the area are upgradient from the site and beyond its influence.

### 4. Analytical Data on Samples Collected

The samples collected at the Melville North Landfill are summarized in Table 5 as previously discussed. The analyses were conducted for the parameters indicated in Table 5 and the detailed laboratory reports on the analyses are included in Appendix C. A summary of these results is presented in Table 15 for the sediment and mussel samples and in Table 16 for the soil samples.

### 5. Evaluation of Available Data

The analytical data on samples collected indicate that there is no significant accumulation of metals or PCBs in sediment or mussels collected at the three marine sampling points. This judgment is based on comparison of the verification step analytical data with the control station data (see Table 15).

TABLE 15  
SUMMARY OF SEDIMENT AND MUSSEL SAMPLE ANALYTICAL DATA  
SITE NO. 02 - MELVILLE NORTH LANDFILL (NOV., 1983)  
(All results in ppm - dry weight basis)

Substrates and Parameters	Site Specific Station Numbers			Control Station Numbers	
	<u>04</u>	<u>05</u>	<u>06</u>	<u>N1</u>	<u>N2</u>
<u>SEDIMENT*:</u>					
PCB	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	4.3	9.3	5.8	11.5	8.0
Cadmium	<0.05	<0.05	<0.05	<0.05	<0.05
Lead	2.3	7.5	5.8	27.5	6.8
Arsenic	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury	<0.02	<0.02	<0.02	<0.02	<0.02
Selenium	<0.2	<0.2	<0.2	<0.2	<0.2
Silver	<0.5	<0.5	<0.5	<0.5	<0.5
Copper	4.0	16.0	5.5	18.3	10.3
Barium	<0.4	<0.4	<0.4	<0.4	<0.4
Nickel	8.3	10.8	10.3	21.3	11.3
Beryllium	<0.05	<0.05	<0.05	<0.05	<0.05
Antimony	<0.5	<0.5	<0.5	<0.5	<0.5
Tin	<5.0	<5.0	<5.0	<5.0	<5.0
<u>MUSSELS:</u>					
PCB	0.08	0.35	0.03	0.36	0.37
Chromium	<2.5	<2.5	<2.5	<2.5	<2.5
Cadmium	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	<0.4	<0.4	<0.4	<0.4	<0.4
Mercury	<0.04	<0.04	<0.04	<0.04	<0.04
Selenium	<0.4	<0.4	<0.4	<0.4	<0.4
Silver	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	<2.5	<2.5	<2.5	7.2	4.3
Barium	<1.0	<1.0	<1.0	<1.0	<1.0
Nickel	<2.5	<2.5	<2.5	<2.5	<2.5
Beryllium	<0.5	<0.5	<0.5	<0.5	<0.5
Antimony	<1.0	<1.0	<1.0	<1.0	<1.0
Tin	<10.0	<10.0	<10.0	<10.0	<10.0

\*All sediment data is for the surface  
sediments at 0 to 4-inch depth

TABLE 16  
SUMMARY OF SOIL SAMPLE ANALYTICAL DATA  
SITE NO. 02 - MELVILLE NORTH LANDFILL (NOV., 1983)  
(All results in ppm - dry weight basis)

<u>Parameter</u>	<u>Composite from Stations 01, 02 and 03</u>
Petroleum Based Hydrocarbon	32,508
Lead	60.0
PCB	<0.5

The composite soil sample indicated the presence of lead and very high concentrations of petroleum based hydrocarbons. No PCBs were found in the soil. As mentioned above, there is no evidence of lead accumulations in sediments or mussels. See Section C for additional evaluation of analytical data on mussel samples.

#### 6. Location of Suspected Contaminant Sources

The only known potential contaminants, <sup>based on the verification analysis,</sup> which could be carried off-site are contained in the oil saturated soil deposits piled in one area on the site. If there are other sources, their effects on the environment, if any, were not detected.

Don't  
like  
@Wkman  
double burning

#### 7. Plan of Action for Further Studies

Further sampling and analysis on this site is necessary to determine the extent to which petroleum based hydrocarbons have migrated from the oil-soaked mounds of earth. The additional sampling should include the sampling program shown in Table 17 and the sampling points shown on Figure No. 11.

TABLE 17  
PROPOSED CHARACTERIZATION SAMPLES  
SITE NO. 02 - MELVILLE NORTH LANDFILL

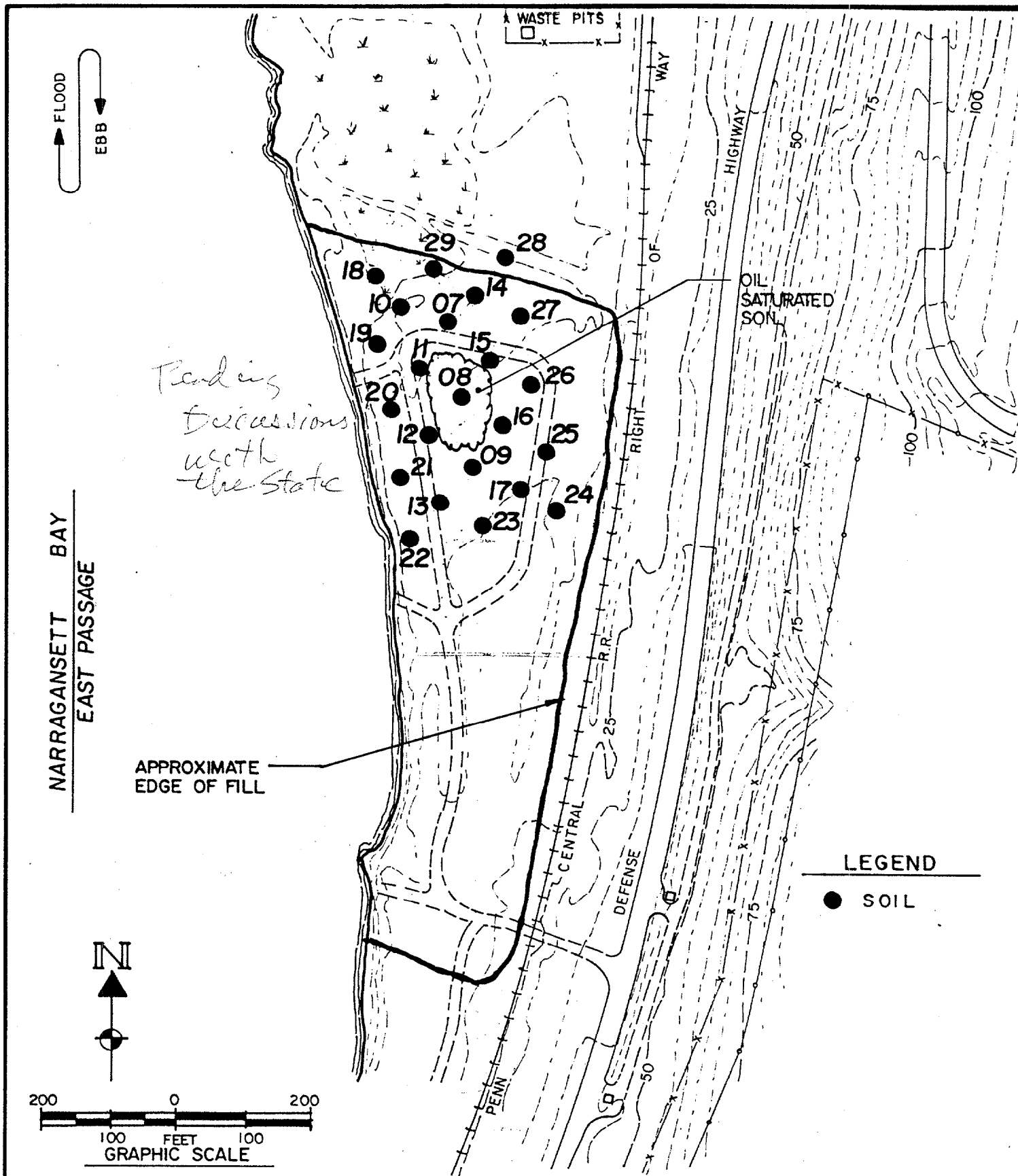
<u>Station Nos.</u>	<u>Sample Type</u>	<u>Number and Frequency of Samples at Each Station</u>
07-29	Soil	1 sample at each of 3 depths (0, 1, 2 feet)

The soil samples should be analyzed for petroleum based hydrocarbons and lead. The analytical data on the verification step samples indicate that no other parameters need to be studied at this site.

The possibility that the oil soaked deposits might be considered non-hazardous was discussed with Rhode Island DEM on the basis that the material is oil spill cleanup debris. However, since the origin of the material is unknown and considerable lead is present, this approach could not be used.

Furthermore, even if this approach had been found acceptable, disposal of the material at a secure landfill outside the State of Rhode Island would still be necessary.

Therefore, the program outlined is directed to soil sampling to determine the extent of lead and PBHC contamination so that the limits of soil removal required, if any, can be determined. A sequential program of sampling and analysis would be conducted until levels of lead and PBHC drop off with distance and depth away from the contaminated soil. The sequence of analyzing the proposed stations would be approximately in numerical order as shown on Figure No. 11.



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**MELVILLE NORTH LANDFILL  
SITE NO 2**  
**PROPOSED CHARACTERIZATION SAMPLING POINTS**



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FEB. 28, 1984  
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**FIG. NO. 11**

## F. FINDINGS AT SITE NO. 07 TANK FARM ONE

### 1. History of Waste Disposal

The history of waste disposal at this site was thoroughly covered in the IAS. The following discussion summarizes the background information contained in the IAS.

Tank Farm One is located in Melville North and consists of six underground tanks. Each of these tanks has a storage capacity of 60,000 barrels. Five of these tanks are now used for the storage of oils including aviation fuel. One tank is no longer used. In the past, these tanks were periodically cleaned to remove the sludge material which, over time, settles on the bottoms of the tanks. This practice occurred from World War II until the 1970's.

When the tanks were cleaned, the sludge material was placed in a pit which was approximately 20 feet long, 10 feet wide, and 4 feet deep. These disposal pits were simply dug in the general vicinity of the tank being cleaned. The sludge was placed in the pits and allowed to weather for a few weeks. The pits were then covered over and marked with signs warning of tetraethyllead. These pits are spread throughout the tank farm, but through the years, most of the signs marking the disposal areas have disappeared. Only two markers remain at this time and samples were collected at those two locations. The third sample was collected at a point which was believed to be a disposal location (near Tank No. 18).

### 2. Existing Site Conditions

The existing site is in active use as a tank farm. It is owned by the Navy but it is operated by a contractor. Disposal of tank sediments on the site has been discontinued as previously mentioned and there is no visible surface evidence of the past tank sediment disposal practices. The site is located well above flood elevation so that any pollutants released from buried tank sediments could escape the site only by migration with the groundwater flow.



When the tanks were installed, groundwater drains were placed around each tank. These were individually valved and piped to a common drain. This drain was later extended to the west where an oil separator is provided to remove oil if present before release of the water to Narragansett Bay. This drain was utilized to obtain a groundwater sample for analysis in the verification step.

The Melville Public Fishing Area is an impoundment located immediately north of Tank Farm One (see Figure No. 5). In 1981 an investigation was conducted by the U.S. Army Environmental Hygiene Agency concerning a complaint of oil discharge to the Melville Public Fishing Area. As part of this investigation, a shallow well was installed near the Melville Public Fishing Area for the purpose of observing groundwater conditions. This well was used for collection of groundwater samples in the verification step. There was no visible evidence of oil pollution in the reservoir at the time of sample collection in the verification step.

The U.S. Army report on the oil spill complaint concluded that the petroleum hydrocarbon material discovered on the Melville Public Fishing Area was not due to leakage in the pipelines or the tanks of the tank farm. The report also recommended that monitoring wells should not be placed in and around the tank farm due to the complex structural geology of the region.

### 3. Hydrogeological Data

The general hydrology of the NETC area was covered in the IAS. The following discussion summarizes the background hydrogeological data contained in the IAS as well as that presented in the more site specific study conducted by the U.S. Army Environmental Hygiene agency in response to the reported oil spill in 1981.

The IAS reported that portions of the tank farm drain northward into the Melville Public Fishing Area, with other areas draining toward Narragansett Bay.

The U.S. Army report, however, indicated that the general groundwater movement is in a northwesterly direction which is one of the reasons they concluded that the existing tanks could not have caused the contamination of the Public Fishing Area.

Of even greater significance to this confirmation study is the complex geology of the area at the Tank Farm One area. The U.S. Army report describes this geology in considerable detail.

The major formation underlying the area is the Pennsylvanian aged, nonmarine, sedimentary formation called the Rhode Island Formation. It underlies the entire region occupied by Narragansett Bay and forms part of a large syncline which plunges to the south. In the vicinity of Tank Farm One, the outcrops and near-surface members are composed of gray to black thin-bedded shale with a few outcrops of thick-bedded graywackes located in the eastern section. All rock layers observed are heavily fractured and jointed with many small displacement normal faults whose strike is at approximate right angles to synclinal strike.

There are numerous fractures, joints and faults in the subsurface. This fracturing is so intense that it was difficult to determine if a major fault system transected the area. Likewise, the fracturing and other complexities make it impossible to reliably interpret subsurface data obtained from borings, excavations or monitoring wells.

The general groundwater elevation at Tank Farm One is about 10 feet below grade. This level is maintained by constant use of the tank underdrainage system mentioned previously to reduce the uplift forces on the oil storage tanks.

#### 4. Analytical Data on Samples Collected

The samples collected at the Tank Farm One site are summarized in Table 6 as previously discussed. The analyses were conducted for the parameters indicated in Table 6 and the detailed laboratory reports on the analyses are included in Appendix C. A summary of these results is presented in Table 18 for the soil samples and in Table 19 for the groundwater samples.

#### 5. Evaluation of Available Data

The analytical data on all samples collected indicate the presence of oil or gasoline contaminants in the soil and groundwater at Tank Farm One. This judgment is based on the magnitude of the oil and grease concentrations in soil samples and the BTX concentrations in groundwater samples. Although some lead was found in the soil samples, the concentrations were relatively low and no lead was found in groundwater. The concentrations of BTX and petroleum based hydrocarbons in the groundwater samples were high; BTX contamination indicates pollutants from light oils such as gasoline.

#### 6. Location of Suspected Contaminant Sources

The analytical data confirms the presence of oil and grease and deposits at the suspected locations of previous tank sediment burial pits.

The analysis of groundwater samples at Station No. 04 confirms that BTX contaminants are present in the groundwaters at one or more of the buried storage tanks numbered 13 to 18 at Tank Farm One.

The groundwater samples at Station No. 03 also exhibited significantly high levels of BTX in groundwater. However, the hydrogeological data developed by the U.S. Army Environmental Hygiene Agency indicates that contaminants found at this sampling point do not originate from Tank Farm One.

TABLE 18  
SUMMARY OF SOIL SAMPLE ANALYTICAL DATA  
SITE NO. 07 - TANK FARM ONE (NOV., 1983)  
(All results in ppm - dry weight basis)

<u>Parameter</u>	<u>Station Numbers</u>		
	<u>01</u>	<u>02</u>	<u>05</u>
Lead	15.3	27.5	8.5
Oil and Grease	2194	1321	2013

TABLE 19  
SUMMARY OF GROUNDWATER SAMPLE ANALYTICAL DATA  
SITE NO. 07 - TANK FARM ONE (NOV., 1983)  
(All results in ppb (ug/l) except as noted)

<u>Parameter</u>	<u>Station Numbers</u>			
	<u>03</u> <u>Dry</u> <u>Weather</u>	<u>04</u> <u>Dry</u> <u>Weather</u>	<u>03</u> <u>Wet</u> <u>Weather</u>	<u>04</u> <u>Wet</u> <u>Weather</u>
Benzene	18	479	160	40
Toluene	281	735	203	59
Xylenes	561	226	91	26
Lead	<40	<40	<40	<40
Petroleum Based Hydrocarbons (ppm)	3.9	2.8	1.6	5.5

TABLE  
WATER SAMPLE  
TANK FARM ONE  
NOV. 1983

## 7. Plan of Action for Further Studies

Further studies are required to define the specific location(s) of sources of BTX and petroleum based hydrocarbons entering the groundwater. Since Tank Farm One is in active use as a fuel storage facility, the scope of such studies would necessarily include, not only past waste disposal practices, but also the existing active facilities (tanks, pipes, drains, pits, manholes, etc.) and their usage. Isolating the source or sources of these contaminants will be extremely difficult because drilling of monitoring wells is not advisable on the site for two reasons: (1) the serious consequences resulting from accidentally drilling into an active fuel line whose location is not precisely known and (2) the presence of geological fractures and other complexities which make it impossible to reliably interpret data from monitoring well logs and sampling.

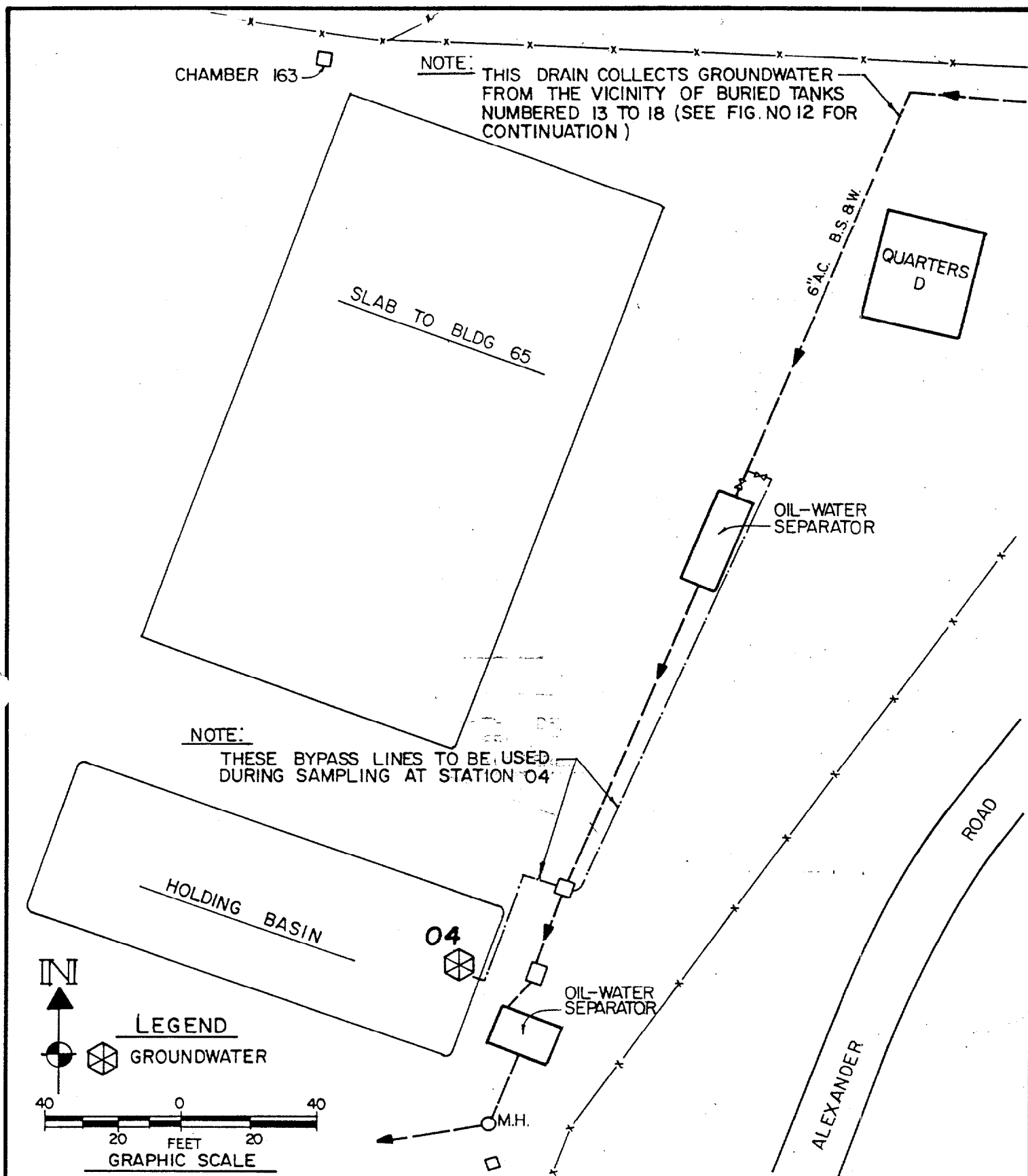
Because of these problems, it is recommended that further efforts to isolate specific sources of contaminants at Tank Farm One be based on a series of additional groundwater samples collected from Station Nos. 03 and 04 to better characterize the types and levels of contamination. In addition, two monitoring wells should be installed north and west of Tank Farm One to determine whether or not pollutants are migrating off-site with the groundwater. It is recognized that the complex geology of the site will make interpretation difficult but this is the only way to make this determination. Four samples from each station are recommended at one month intervals. This recommended program is summarized in Table 20. The locations of the tanks and sampling points are shown on Figure Nos. 12 and 13.

Soil samples should be obtained from the same stations as in the verification step because the earlier samples are too old for the analyses proposed. The samples should be analyzed for oil identification utilizing high

TABLE 20  
PROPOSED CHARACTERIZATION SAMPLES  
SITE NO. 07 - TANK FARM ONE

<u>Station Nos.</u>	<u>Sample Type</u>	<u>Number and Frequency of Samples at Each Station</u>
03-04, 06-07	Groundwater	4 samples one month apart
01, 02 05	Soil	One sample at 3-4 feet deep.





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TANK FARM ONE—OIL-WATER SEPARATOR  
SITE NO 07  
PROPOSED CHARACTERIZATION SAMPLING POINTS



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FIG. NO. 13



resolution gas chromatography to match the characteristics of oils in the soil with oils found in the groundwater samples.

This program will provide information on the releases, if any, to the off-site environment from Tank Farm One as a whole and would not isolate the specific part or parts of the site causing any problem which may be detected. The latter is probably not practical because of the complex geology described for Tank Farm One; however, the hydrogeological data on the site does indicate a general northerly and/or westerly groundwater movement which would be intercepted by the proposed new groundwater monitoring wells. These wells would be drilled at least 15 feet below the groundwater level which would be determined at the time of drilling. An upgradient monitoring well was not considered necessary because of the absence of any known sources of oil contamination.

Screen  
Placement  
on top of  
aquifer

## G. FINDINGS AT SITE NO. 12 TANK FARM FOUR

### 1. History of Waste Disposal

The history of waste disposal at this site was thoroughly covered in the IAS. The following discussion summarizes the background information contained in the IAS.

This site has 12 concrete underground tanks, each with a capacity of 60,000 barrels. These tanks were used to store diesel and fuel oil but their use was discontinued several years ago, when they were emptied (but not cleaned) and refilled with water.

During the period of active use of the tanks, the bottom sludge was periodically removed and disposed of by burning; however, there was some suspicion that the cleanings were disposed of on the ground in the general vicinity of the tank being cleaned. There is no indication on the site as to specifically where these deposits, if any, were made.

### 2. Existing Site Conditions

The site is no longer used as a tank farm. The tanks are filled, or partially filled with water and/or oil and are reported to contain any sediments or oil residues remaining when the tanks were emptied upon deactivation of the tank farm. No further waste disposal activities have taken place since deactivation and there is no visible surface evidence of the past tank sediment disposal practices. The site is located well above flood elevation so that any pollutants released from buried tank sediments could escape only by migration with the groundwater flow.

Norman's Brook flows across the southwest corner of the site just before discharging into Narragansett Bay. A swale carries intermittent wet weather runoff westerly from the vicinity of Tank No. 41 to Norman's Brook. When this

runoff was sampled in the verification step, the source of the runoff was seepage out of the ground in the more steeply sloped areas near the swale. The northern part of the site drains toward Narragansett Bay but not via Norman's Brook.

### 3. Hydrogeological Data

The general hydrogeology of the NETC area was covered in the IAS. The following discussion summarizes the background hydrogeological data contained in the IAS.

The groundwater in areas close to the bay is often within just two or three feet of the surface. Soil sampling and other observations made during the verification step sampling confirm that the groundwater level is at about this level. The groundwater moves in a westward direction and discharges into Narragansett Bay. There was no evidence of any direct leachate discharges into the Bay. The groundwater is not being utilized at NETC. Any wells in the area are upgradient from the site and beyond its influence.

### 4. Analytical Data on Samples Collected

The samples collected at the Tank Farm One Site are summarized in Table 7 as previously discussed. The analyses were conducted for the parameters indicated in Table 7 and the detailed laboratory reports on the analyses are included in Appendix C. A summary of these results is presented in Table 21.

### 5. Evaluation of Available Data

The analytical data on samples collected indicate that there is oil and grease contamination in the soil and some petroleum based hydrocarbon contamination in sediments in a wet weather brook on the south side of the site. There was a low level of petroleum based hydrocarbon contamination in the runoff in this brook.

G-2nd

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE 21  
SUMMARY OF SURFACE WATER, SOIL AND SEDIMENT SAMPLE ANALYTICAL DATA  
SITE NO. 12 - TANK FARM FOUR (NOV., 1983)

<u>Parameter</u>	<u>Station Numbers and Sample Types</u>		
	<u>01 to 06 Composite Soil Sample</u>	<u>09 Sediment</u>	<u>09 Surface Water</u>
Lead	3.25 ppm	<0.5 ppm	<0.04 mg/l
Petroleum Based Hydrocarbons	*	478 ppm	3.6 mg/l
Oil and Grease	216 ppm		

\*No analysis performed

## 6. Location of Suspected Contaminant Sources

The analytical data indicate that one or more of the soil samples (Station Nos. 01 to 06) is high in lead and/or oil and grease and that some petroleum based hydrocarbons may be escaping via surface runoff. The sources of these contaminants could be either of the following:

- Undefined locations of burial or dumping areas for tank bottom sediments.
- Leakage from tanks numbered 37 to 48 which were emptied but not cleaned when taken out of service.

## 7. Plan of Action for Further Studies

It is recommended that additional samples be collected to determine whether or not contaminants in the soils and/or in the abandoned tanks are escaping from the site. These samples should be collected from two new monitoring wells along the west and south boundaries of the site.

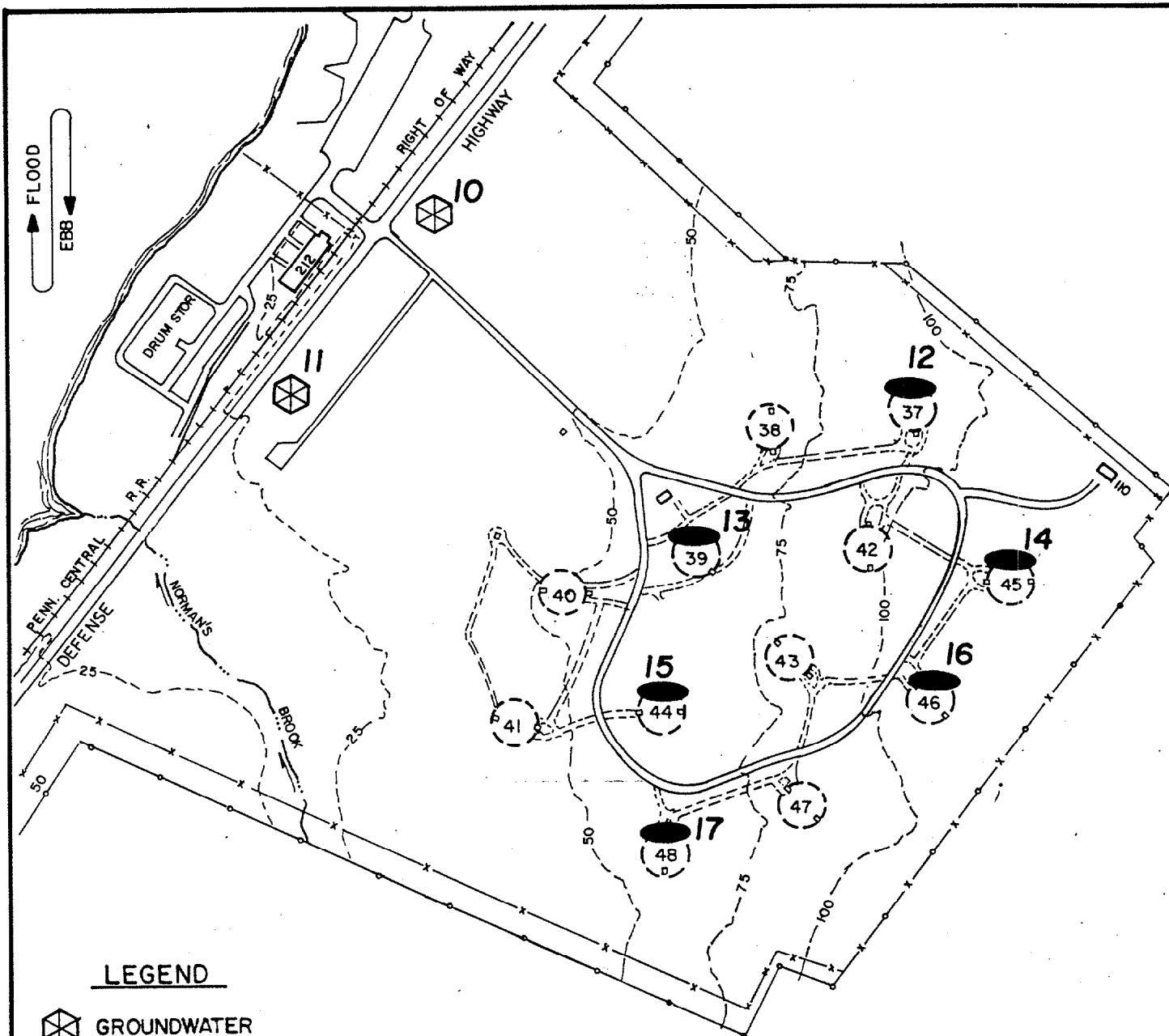
The sampling program is summarized in Table 22 and is shown on Figure 14. The samples should be analyzed for lead and petroleum based hydrocarbons.

This program will provide information on the releases, if any, to the off-site environment from Tank Farm Four as a whole and will not isolate the specific part or parts of the site causing any problem which may be detected. The latter is probably not practical because the complex geology described for Tank Farm One probably also applies to Tank Farm Four as well. The available hydrogeological data on the site does indicate a general westerly groundwater movement which would be intercepted by the proposed new groundwater monitoring wells. These wells would be drilled at least 15 feet below the groundwater level which would be determined at the time of drilling. An upgradient monitoring well was not considered necessary because of the absence of any known sources of oil contamination.

Because of the likelihood that one or more tanks may be leaking or may leak in the future, the sampling program should include samples of the water phase of six of the 12 tanks so that the handling and disposal of the water can be resolved as part of a program of removal, salvage, and disposal of the tank contents. This would remove a major potential source of oil contamination.

After removing the oil from the tanks, the monitoring wells could be used for long term observations, if necessary, to determine if any pollutants are present.

Are there reg or proposed  
Reg on Abandoned  
fuel tanks in the State



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# TANK FARM FOUR SITE NO 12 PROPOSED CHARACTERIZATION SAMPLING POINTS



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FIG. NO. 14

TABLE 22  
PROPOSED CHARACTERIZATION SAMPLES  
SITE NO. 12 - TANK FARM FOUR

<u>Station Nos.</u>	<u>Sample Type</u>	<u>Number and Frequency of Samples at Each Station</u>
10-11	Groundwater	4 samples one month apart
12-17	Water in Tank	One sample of the water phase from six of the storage tanks.



## H. FINDINGS AT SITE NO. 14 GOULD ISLAND DISPOSAL AREA

### 1. History of Waste Disposal

The history of waste disposal at this site was thoroughly covered in the IAS. The following discussion summarizes the background information contained in the IAS.

This site was used throughout the World War II period and received all the wastes generated on the island. Some wastes were incinerated on the site and the ash was dumped on the site along with other wastes. The deposits were made on a steep slope facing Narragansett Bay on the west side of the island. The site was last used about 30 years ago. In addition to the normal types of industrial refuse, there was considerable waste production from electroplating and degreasing operations on the island during World War II. Wastes from these operations would have gone to this site unless they were discharged directly into Narragansett Bay. These wastes would have included muriatic acid, chromic acid, copper cyanide, sodium cyanide, sodium hydroxide, nickel sulfate, and Anodex cleaner.

### 2. Existing Site Conditions

This site is located along the shoreline of Narragansett Bay on the west side of Gould Island. The disposal area is situated along an embankment which drops down steeply to a beach area. The length of the landfill along the shoreline is about 200 yards. The extent of the waste deposits inland to the east is not known but is probably not more than 100 yards at any point. The site is not in use and is on land being excessed by the Government.

Most of the site is vegetated. However, waste deposits are exposed at many locations particularly at the lower levels where the wastes come into direct contact with the waters of Narragansett Bay at high tide. Surface runoff from the site is directly into the Bay. There are no significant areas where ponding in surface water occurs over the fill area.

The shoreline contains accumulations of waste materials such as metal scrap, wood, pipes, rusted out drums, concrete blocks, and oil tanks.

### 3. Hydrogeological Data

The general hydrogeology of the NETC area was covered in the IAS. The following discussion summarizes the conclusions drawn from background hydrogeological data contained in the IAS.

The landfill site is so steeply sloped that there is no question that groundwater moves in a westward direction and discharges into Narragansett Bay. The groundwater recharge area on the island is so small that no significant groundwater flow can be anticipated except in very wet seasons. These factors and the history of waste deposition onto the steep embankment along the coastal area indicate that the hydrogeology of the site is characterized by groundwater movement in very thin layers toward the Bay. There was no evidence of any direct leachate discharges into the Bay. The groundwater is not being utilized at NETC and there are no known wells on the Island.

### 4. Analytical Data on Samples Collected

The samples collected at the Gould Island Disposal Area site are summarized in Table 8 as previously discussed. The analyses were conducted for the parameters indicated in Table 8 and the detailed laboratory reports on the analyses are included in Appendix C. A summary of these results is presented in Table 23.

### 5. Evaluation of Available Data

The analytical data on samples collected indicate that metals are accumulating in sediments and mussels near the Gould Island Disposal area. This judgment is based on comparison of the verification step sampling and analytical data with the control station data (see Table 23).

TABLE 23  
SUMMARY OF SEDIMENT AND MUSSEL SAMPLE ANALYTICAL DATA  
SITE NO. 14 - GOULD ISLAND DISPOSAL AREA (NOV., 1983)  
(All results in ppm - dry weight basis)

Substrates and Parameters	Site Specific Station Numbers			Control Station Numbers	
	<u>01</u>	<u>02</u>	<u>03</u>	<u>N1</u>	<u>N2</u>
<u>SEDIMENT*:</u>					
PCB	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	8.0	17.8	15.0	11.5	8.0
Cadmium	<0.05	<0.05	<0.05	<0.05	<0.05
Lead	70.0	310.	270.	27.5	6.8
Arsenic	<0.2	<0.2	<0.2	<0.2	<0.2
Mercury	<0.02	<0.02	<0.02	<0.02	<0.02
Selenium	<0.2	<0.2	<0.2	<0.2	<0.2
Silver	<0.5	<0.5	<0.5	<0.5	<0.5
Copper	134.	242.	292.	18.3	10.3
Barium	<0.4	<0.4	<0.4	<0.4	<0.4
Nickel	14.3	29.3	29.0	21.3	11.3
Beryllium	<0.05	<0.05	<0.05	<0.05	<0.05
Antimony	<0.5	<0.5	<0.5	<0.5	<0.5
Tin	<5.0	<5.0	<5.0	<5.0	<5.0
<u>MUSSELS:</u>					
PCB	0.23	0.17	0.16	0.36	0.37
Chromium	<2.5	<2.5	<2.5	<2.5	<2.5
Cadmium	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic	<0.4	<0.4	<0.4	<0.4	<0.4
Mercury	<0.04	<0.04	<0.04	<0.04	<0.04
Selenium	<0.4	<0.4	<0.4	<0.4	<0.4
Silver	<1.0	<1.0	<1.0	<1.0	<1.0
Copper	7.5	17.5	9.5	7.2	4.3
Barium	<1.0	<1.0	<1.0	<1.0	<1.0
Nickel	<2.5	<2.5	<2.5	<2.5	<2.5
Beryllium	<0.5	<0.5	<0.5	<0.5	<0.5
Antimony	<1.0	<1.0	<1.0	<1.0	<1.0
Tin	<10.0	<10.0	<10.0	<10.0	<10.0

\*All sediment data is for the surface  
sediments at 0 to 4-inch depth

The surface layer of sediment at all three sampling points exhibited significantly high values of lead and copper. In addition, slightly high values of nickel and chromium were evident at two of the stations (by comparison to the control stations), but these do not appear to be significant. No PCB contamination was found in any of the sediment samples.

Slightly elevated copper concentrations were found in mussels by comparison to the controls. These do not appear to be significantly high, however. No other metals were found in the mussel samples. The PCB levels in mussels were lower than those found in the controls. See Section C for additional evaluation of analytical data on mussels.

#### 6. Location of Suspected Contaminant Sources

Neither the field reconnaissance nor the analytical data provide information to define the location of suspected contaminant sources. The location of the sediment sample points with the highest metal concentration are not the same for the various metals. Station No. 02 exhibited the highest copper concentration in mussels.

#### 7. Plan of Action for Further Studies

Additional sampling and analysis is needed to determine if the landfill is releasing contaminants to Narragansett Bay and, if so, to identify the mechanism by which the contaminants are being released. The studies should be limited to investigation of cyanide, chromium, lead, copper and nickel since there was no evidence of the presence of any other pollutants in the verification step samples.

The additional sampling should include the program shown in Table 24 and the sampling points should be as shown on Figure 15. All samples should be analyzed for:

Lead  
Copper  
Chromium

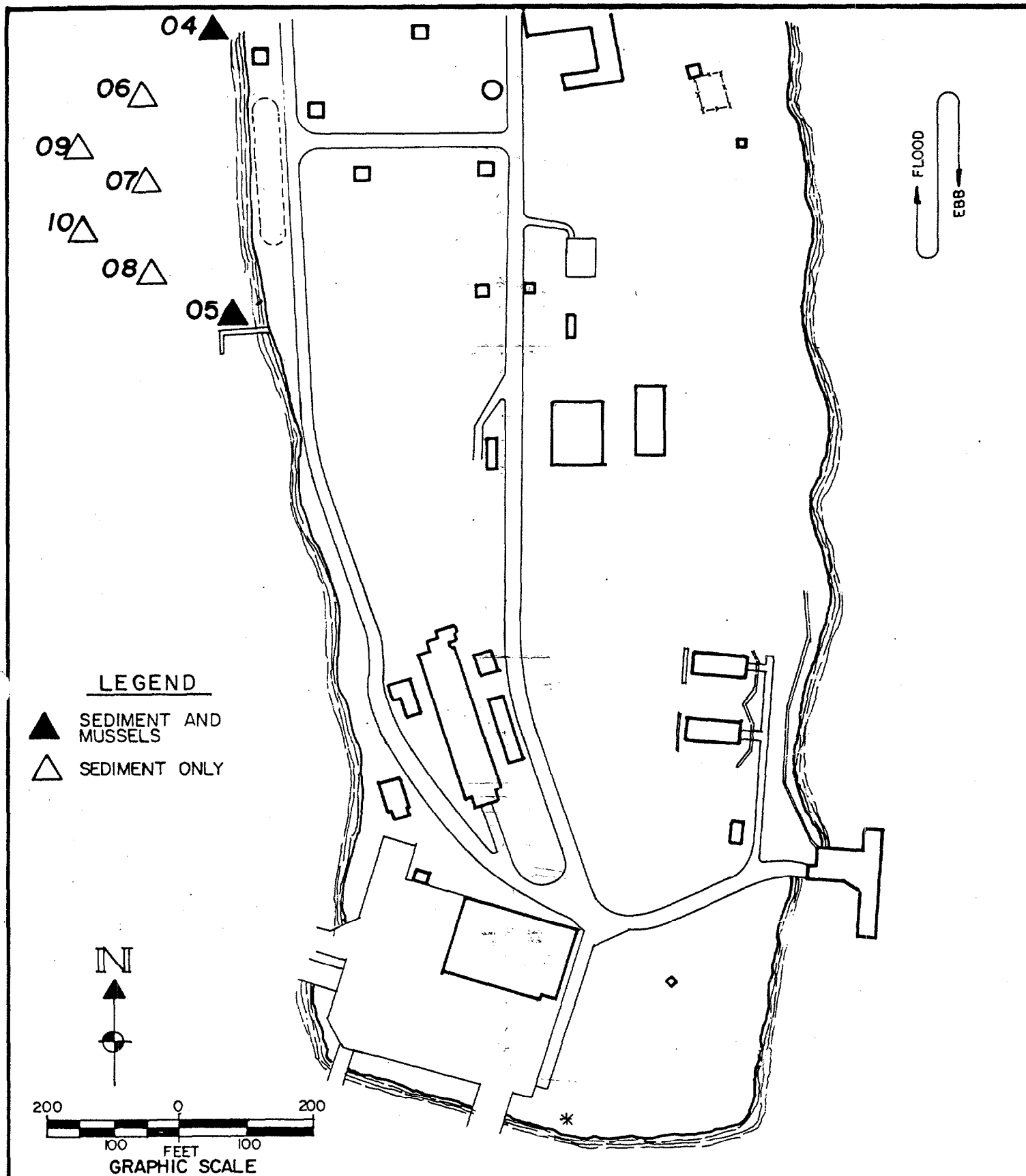
Nickel  
Cyanide

The sediment samples will indicate the extent of existing metals deposits laterally and vertically. The mussel samples will indicate the lateral extent of the biological effects.

Consideration was given to collection of groundwater samples but this was not considered feasible because of the absence of any significant groundwater flow and no known leachate discharge. Additionally, for logistical reasons groundwater samples would be very difficult to obtain. Well installation equipment would be expensive to mobilize on the island and this may not be feasible.

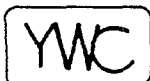
TABLE 24  
PROPOSED CHARACTERIZATION SAMPLES  
SITE NO. 14 - GOULD ISLAND DISPOSAL AREA

<u>Station Nos.</u>	<u>Sample Type</u>	<u>Number and Frequency of Samples at Each Station</u>
04-10	Sediment	1 sample at each of 3 depths (0, 1, 2 feet if conditions permit)
04 & 05	Mussels	1 sample from intertidal zone



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GOULD ISLAND DISPOSAL AREA  
SITE NO 14  
PROPOSED CHARACTERIZATION SAMPLING POINTS



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FIG. NO. 15

## I. FINDINGS AT SITE NO. 17 GOULD ISLAND ELECTROPLATING SHOP

### 1. History of Waste Disposal

The history of waste disposal at this site was thoroughly covered in the IAS. The following discussion summarizes the background information contained in the IAS.

Extensive electroplating and degreasing operations occurred on Gould Island (Building 32) during World War II. These operations existed only during the war. The wastes generated included muriatic acid, chromic acid, copper cyanide, sodium cyanide, sodium hydroxide, nickel sulfate, Anodex cleaner, and degreasing solvents. The method of disposal could not be verified. However, rinse water was most likely discharged into the bay while concentrated spent plating solutions were probably bled slowly into the wastewater stream. Plating sludges, on the other hand, were probably disposed of in the landfill (Site No. 14).

### 2. Existing Site Conditions

This site is located at Building 32 and the two wastewater discharge lines into Narragansett Bay on the east side of Gould Island. The electroplating shop is not in use and the property is on land to be retained by the Navy. There are no wastewater discharges from the two discharge pipes with the possible exception of roof drainage. The end of the discharge pipe at Station 01 (Figure No. 9) was located at the time of verification-step sample collection. The end of the other pipe could not be located because of silt and vegetation accumulations over the pipe.

Hydrogeological data was not obtained on this site since it is not pertinent to the study.

### 3. Analytical Data on Samples Collected

The samples collected at the Gould Island Electroplating Shop site are summarized in Table 9 as previously discussed. The analyses were conducted

for the parameters indicated in Table 9 and the detailed laboratory reports on the analyses are included in Appendix C. A summary of these results is presented in Table 25.

#### 4. Evaluation of Available Data

The analytical data on samples collected indicate that slightly elevated concentrations of cyanide and copper are present in sediments and an elevated concentration of copper is present in mussels collected from the vicinity of one of the discharge pipes at the Gould Island Electroplating Shop. This judgment is based on comparison of the verification step sampling and analytical data with the control station data (see Table 24). See Section C for additional evaluation of analytical data on mussels.

#### 5. Plan of Action for Further Studies

Additional sampling is needed to confirm the level of contaminants in mussels at Station 01. The additional sampling should include the program shown in Table 26 and the sampling points should be as shown in Figure No. 16. All samples should be analyzed for chromium, copper, lead, cadmium and nickel.



TABLE 25  
SUMMARY OF SEDIMENT AND MUSSEL SAMPLE ANALYTICAL DATA  
SITE NO. 17 - GOULD ISLAND ELECTROPLATING SHOP (DEC., 1983)  
(All results in ppm - dry weight basis)

Substrates and Parameters	Site Specific Station Numbers		Control Station Numbers	
	<u>01</u>	<u>02</u>	<u>N1</u>	<u>N2</u>
<u>SEDIMENT*:</u>				
Cyanide	0.121	0.111	0.031	0.027
Chromium	<0.25	<0.25	11.5	8.0
Cadmium	<0.05	<0.05	<0.05	<0.05
Lead	<0.5	6.5	27.5	6.8
Mercury	<0.02	<0.02	<0.02	<0.02
Silver	<0.5	<0.5	<0.5	<0.5
Copper	26.0	17.4	18.3	10.3
Nickel	<0.25	<0.25	21.3	11.3
<u>MUSSELS:</u>				
Chromium	<2.5	<2.5	<2.5	<2.5
Cadmium	<0.5	<0.5	<0.5	<0.5
Lead	<1.0	<1.0	<1.0	<1.0
Mercury	<0.04	<0.04	<0.04	<0.04
Silver	<1.0	<1.0	<1.0	<1.0
Copper	6.0	26.3	7.2	4.3
Nickel	<2.5	<2.5	<2.5	<2.5

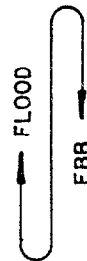
TABLE 25  
SEDIMENT AND MUSSEL SAMPLE ANALYTICAL DATA  
SITE NO. 17 - GOULD ISLAND ELECTROPLATING SHOP (DEC., 1983)

\*All sediment data is for the surface dry weight of sediments at 0 to 4-inch depth

Site Station

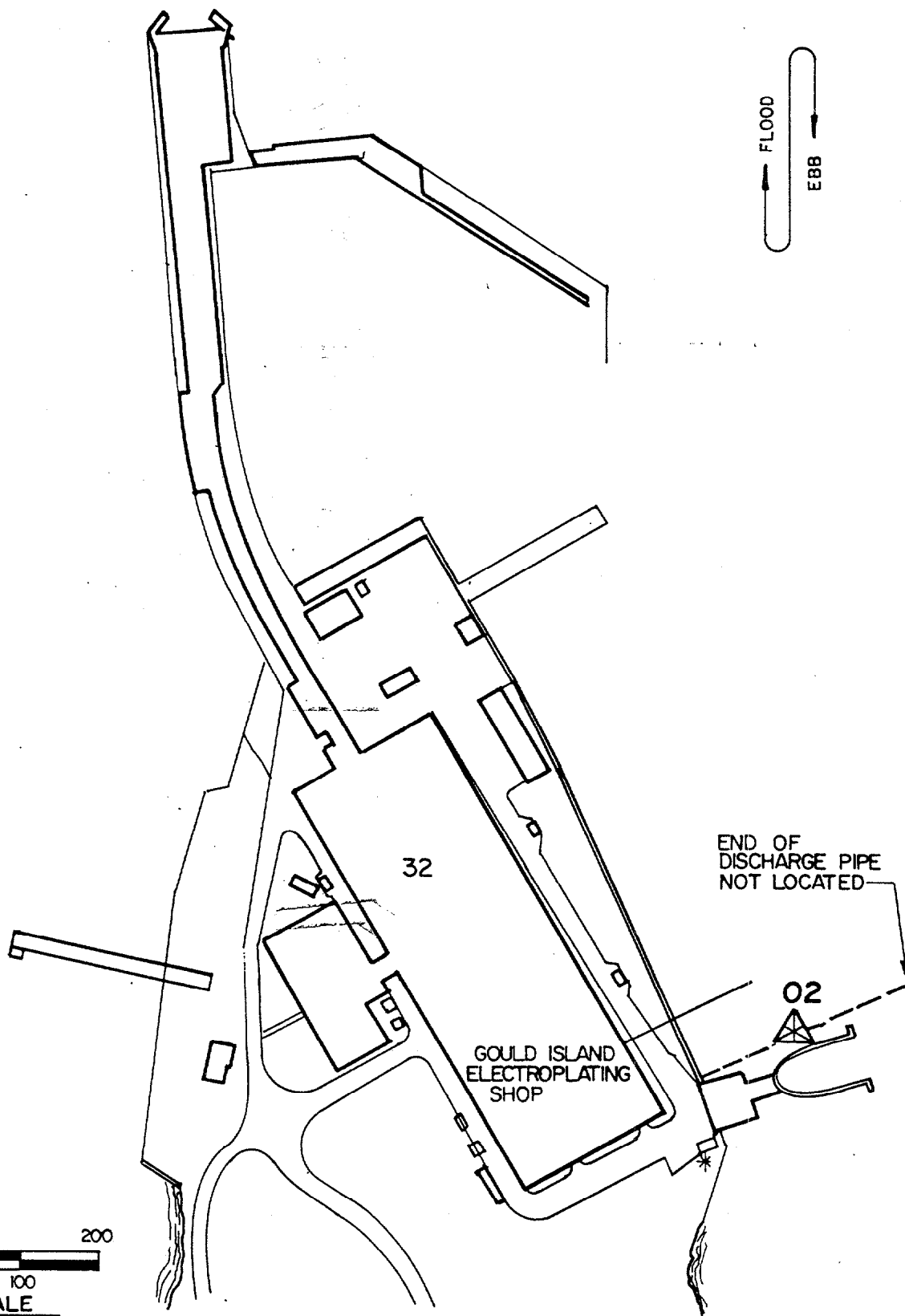
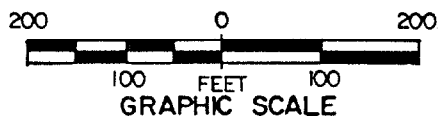
TABLE 26  
PROPOSED CHARACTERIZATION SAMPLES  
SITE NO. 17 - GOULD ISLAND ELECTROPLATING SHOP

<u>Station Nos.</u>	<u>Sample Type</u>	<u>Number and Frequency of Samples at Each Station</u>
02	Mussels	1 sample from intertidal zone



### LEGEND

 MUSSELS ONLY



CONFIRMATION STUDY  
ON HAZARDOUS WASTE SITES  
NEWPORT NAVAL EDUCATION &  
TRAINING CENTER

GOULD ISLAND ELECTROPLATING SHOP  
SITE NO 17  
PROPOSED CHARACTERIZATION SAMPLING POINTS



York Wastewater Consultants, Inc.  
Stamford, Connecticut



LOUREIRO ENGINEERING ASSOCIATES  
a professional corporation  
CONSULTING ENGINEERS  
AVON, CT.

MAY, 8, 1984

FIG. NO. 16

## J. TOXICITY DATA

### 1. General

Marine aquatic toxicology has developed and relied on laboratory bioassays that test the effects of single pollutants on marine species. The literature is replete with 24-hour to 96-hour LD-50 bioassay data collected on a few marine species of fish, invertebrates or phytoplankton that scientists were able to hold or rear in the laboratory. However, some of these data have been questioned and are difficult to compare because different methodologies were used and often the chemical monitoring of the assay relied on calculated rather than measured concentrations. Furthermore, it is now evident that bioassays are generally conducted on hardy species and rarely on sensitive, ecologically or commercially important species. Thus, they may be of little use in determining the impact of a pollutant stress on the system to be protected.

However, in order to give the reader a general feeling for the toxicity of parameters which were found to be present at levels significantly above background levels and for the which further investigations are recommended, some of the above-referenced literature is summarized below. The majority of the information presented in the following sections was taken from the U.S. Environmental Protection Agency's "Red Book" published in 1976, the National Academy of Sciences/National Research Council Publication, Drinking Water and Health published in 1977, and the priority toxic pollutant criteria published by EPA in 1980.

### 2. Cadmium

Cadmium is a soft, bluish-white, easily fusible metal similar to zinc and lead in many properties and readily soluble in mineral acids. Biologically, cadmium is a nonessential, nonbeneficial element recognized to be of high toxic

potential. It is deposited and accumulated in various body tissues and is found in varying concentrations throughout all areas where man lives. Cadmium may function in or may be an etiological factor for various human pathological processes including testicular tumors, renal dysfunction, hypertension, arteriosclerosis, growth inhibition, chronic diseases of old age, and cancer. Cadmium has been shown to be toxic to man when ingested or inhaled. Exposure by the former route causes symptoms resembling food poisoning. The EPA recommends criteria of 10 ppb for domestic water supply and, for protection of marine aquatics, 4.5 ppb as a 24-hour average - never to exceed 59.0 ppb at any time.

Zarogian, as reported by Eisler (1974), states that adult oysters, *Crassostrea virginica*, exposed to 10 ug/l cadmium between April and August, 1973 accumulated 18,000 ug/kg of cadmium in wet whole meat, which exceeds the human emetic threshold of 13,000 to 15,000 ug/kg. Oysters retained virtually all of the accumulated cadmium for at least several months and some histopathology was evident. Under natural conditions, significantly greater numbers of larvae from cadmium-stressed oysters failed to develop when compared to controls after 48 or 72 hours. A criterion of one-half of the level at which oysters accumulate cadmium in excess of the human emetic threshold, 5 ug/l, is believed to provide protection for consumers of oysters. Edible marine organisms can concentrate cadmium levels and become hazardous to the ultimate consumer. Lowman, et al. (1971) reported a concentration factor of 1,000 for cadmium in fish muscle. The criteria necessary to protect fish and other aquatic life are more stringent than those necessary to protect a public water supply or other uses.

### 3. Copper

Copper, a reddish-brown metal is an essential trace element for the propagation of plants and performs vital functions in several enzymes and a

major role in the synthesis of chlorophyll. A shortage of copper in soil may lead to chlorosis which is characterized by yellowing of plant leaves. In copper-deficient soils, it may be added as a trace nutrient supplement to other fertilizers.

Copper is required in animal metabolism. It is important in invertebrate blood chemistry and for the synthesis of hemoglobin. In some invertebrate organisms a protein, hemocyanin, contains copper and serves as the oxygen-carrying mechanism in the blood. An overdose of ingested copper in mammals acts as an emetic.

Concentrations of copper found in natural waters are not known to have an adverse effect on humans. Prolonged oral administration of excessive quantities of copper may result in liver damage, but water supplies seldom have sufficient copper to effect such damages. Young children require approximately 0.1 mg/day of copper for normal growth and the daily requirement for adults was estimated to be about 2 mg/day (Sollman, 1957). Copper in excess of 1 mg/l may impart some taste to water. Because of a possible undesirable taste in drinking water at higher concentrations, the EPA recommends a limit of 1 mg/l.

Copper is present in seawater at a concentration of approximately 3 ug/l but copper added to the marine environment is readily precipitated in the alkaline and saline environment. Toxicity of copper to fishes in marine waters has not been studied, but for *Nereis virens*, a polychaete invertebrate, the toxic threshold for copper was 100 ug/l (Raymont and Shields, 1964). Copper is toxic to oysters at concentrations above 100 ug/l (Galtsoff, 1932). Clendenning and North (1960) found inhibition of photosynthesis in the giant kelp, *Macrocystis pyrifera*, at copper concentrations of 60 ug/l. This commercially important marine plant is used for several industrial processes and for important food additives.

Adult softshell clams, *Mya arenaria*, were the most sensitive marine macroorganisms tested in static copper toxicity bioassays.  $LC_0$ ,  $LC_{50}$ , and  $LC_{100}$  values after 168 hours at 30 o/oo salinity and 22°C were 25, 35 and 50 ug/l respectively. At 17°C, these values were 75, 86 and 100 ug/l, respectively, for the same time period. Copper is selectively concentrated over zinc by adult softshell clams, *Mya arenaria*. Concentrations of greater than 20 ug/l are fatal after exposure for several weeks (Pringle, et al. 1968). The 9-day  $LC_{50}$  for newly hatched *Fundulus heteroclitus* larvae was 160 ug/l (Gentle, 1975).

To protect marine aquatic life, criteria of 4.0 ug/l as a 24-hour average, not to exceed 23.0 ug/l at any time are recommended.

#### 4. Cyanide

Cyanide is one of the simplest and most readily formed organic moieties. Cyanide and compounds of cyanide are almost universally present where life and industry are found. Besides being very important in a number of manufacturing processes, they are found in many plants and animals as metabolic intermediates which generally are not stored for long periods of time.

Cyanide toxicity is essentially an inhibition of oxygen metabolism, i.e., rendering the tissues incapable of exchanging oxygen. The cyanogen compounds are true, noncumulative, protoplasmic poisons (can be detoxified readily) since they arrest the activity of all forms of animal life. Cyanide shows a very specific type of toxic action. It inhibits the cytochrome oxidase system which functions in the electron transfer from reduced metabolites to molecular oxygen. The ferric iron-porphyrin molecule responsible for the catalytic action of cytochrome oxidase is the reactive site where cyanide combines with ferric (+++) iron atoms to form a reversible complex. Other enzymes containing a metal

porphyrin molecule, e.g., peroxidases and xanthine oxidase, are also strongly inhibited by cyanide. Only undissociated HCN inhibits the consumption of oxygen in the tissues, causing cellular asphyxia (histotoxic anoxia) by attaching itself to the iron of the prosthetic group of the enzyme cytochrome oxidase.

Cyanide ingested by humans at quantities of 10 mg or less per day is not toxic and is biotransformed to the less toxic thiocyanate. Lethal toxic effects from the ingestion of water containing cyanide occur only when cyanide concentrations are high and overwhelm the detoxifying mechanisms of the human body. Continuous long term consumption of up to nearly 5 mg per day has shown no injurious effects (Bodansky and Levy, 1923).

As of 1980, the criteria to protect marine aquatic life are: 30 ug/l on an acute toxicity basis, and 2.0 ug/l on a chronic toxicity basis. In 1976, the EPA criterion was 5 ug/l for marine and freshwater aquatic life and wildlife.

## 5. Lead

Most lead salts are of low solubility. Lead is a very soft blue-gray metal and exists in nature mainly as lead sulfide (galena); other common natural forms are lead carbonate (cerussite), lead sulfate (anglesite), and lead chlorophosphate (pyromorphite). Stable complexes results also from the interaction of lead with the sulfhydryl, carboxyl, and amine coordination sites characteristically found in living matter. The toxicity of lead in water, like that of other heavy metals, is affected by pH, hardness, organic materials, and the presence of other metals. The aqueous solubility of lead ranges from 500 ug/l in soft water to 3 ug/l in hard water.

Mediterranean and Pacific surface waters contain up to 0.20 and 0.35 mg/l of lead, respectively (NAS, 1972), which is about 10 times the estimated pre-industrial lead content of marine waters.



As far as is known, lead has no beneficial or desirable nutritional effects. Lead is a toxic metal that tends to accumulate in the tissues of man and other animals. Although seldom seen in the adult population, irreversible damage to the brain is a frequent result of lead intoxication in children. The major toxic effects of lead include anemia, neurological dysfunction, and renal impairment. The most common symptoms of lead poisoning are anemia, severe intestinal cramps, paralysis of nerves (particularly of the arms and legs), loss of appetite, and fatigue; the symptoms usually develop slowly. High levels of exposure produce severe neurologic damage, often manifested by encephalopathy and convulsions; such cases frequently are fatal. Lead is strongly suspected of producing subtle effects (i.e., effects due to low level or long term exposures insufficient to produce overt symptoms) such as impaired neurologic and motor development and renal damage in children (EPA, 1973). Subclinical lead effects are distinct from those of residual damage following lead intoxication.

The lead content in public water supplies in the U.S. in 1962 ranged from traces to 62 ug/l (Durfor and Becker, 1964). Continuous monitoring of the U.S. water supplies since 1962 has demonstrated that their lead content has, in general, not exceeded the U.S. Public Health Service standard of 50 ug/l (USPHS, 1962). In drinking water, lead should be kept to a minimum; a criterion of 50 ug/l is attainable and protective. Experience indicates that fewer than 4 percent of the water samples analyzed exceed the 50 ug/l limit and that the majority of these are due to corrosion problems and are not due to naturally occurring lead content in raw waters.

There is no question that some marine organisms can concentrate the lead present in seawater. Wilder (1952) reported lobster dying in 6 to 20 days when held in lead-lined tanks. Calabrese, et al. (1973) found a 48-hour LC<sub>50</sub> of

1,730 ug/l and a 48-hour  $LC_{50}$  of 2,450 ug/l for oyster, *Crassostrea virginica*, eggs. The remarkable ability of the eastern oyster, *Crassostrea virginica*, to concentrate lead was demonstrated (Pringle, et al. 1968) by exposing them to flowing seawater containing lead concentrations of 25 ug/l, 50 ug/l, 100 ug/l and 200 ug/l; after 49 days, the total accumulation of lead amounted to 17, 35, 75 and 200 ppm (wet weight), respectively, and those oysters exposed to the two highest lead levels, upon gross examination, showed considerable atrophy and diffusion of the gonadal tissue, edema, and less distinction of hepatopancreas and mantle edge.

North and Clendenning (1958) reported that lead nitrate at 4.1 mg/l of lead showed no deleterious effect on the photosynthesis rate in kelp, *Macrosystis pyrifera*, exposed for 4 days. The EPA has suggested marine aquatic criterion for acute and chronic toxicity of 668 ug/l and 25 ug/l respectively. These levels would be lower for more sensitive species which have not been tested.

#### 6. Nickel

Nickel is a silver-white, hard metallic element seldom occurring in nature in the elemental form. Nickel salts are soluble and can occur as a leachate from nickel-bearing ores. Kopp and Kroner (1967) detected nickel in the Lake Erie Basin at a frequency of 53 percent and a mean concentration of 56 ug/l. At several selected stations, dissolved nickel ranged from 3 to 86 ug/l and suspended nickel from 5 to 900 ug/l. Nickel is present in seawater at 5 to 7 ug/l (NAS, 1974).

Nickel is considered to be relatively nontoxic to man (Schroeder, et al. 1961) and a limit for nickel is not included in the EPA National Primary Drinking Water Regulations. However, to protect human health, a criterion of 13.4 ug/l is recommended. The toxicity of nickel to aquatic life, as reported

by McKee and Wolf (1963), indicates tolerances that vary widely and that are influenced by species, pH, synergistic effects, and other factors.

Calabrese, et al. (1973) reported a 48-hour  $LC_{50}$  of 1,180 ug/l for American oyster embryos, *Crassostrea virginica*, and 310 ug/l for embryos of the hard shell clam, *Mercenaria mercenaria* (Calabrese and Nelson, 1974). Jones (1939) reported a 96-hour  $LC_{50}$  of 800 ug/l for the euryhaline stickleback, *Gasterosteus aculeatus*. Gentile (1975) found that the 96-hour  $LC_{50}$  for the marine copepod, *Acartia tonsa*, was 625 ug/l. To protect marine aquatic life the criterion are: 7.1 ug/l as a 24-hour average never to exceed 140 mg/l.

Nickel salts have been shown to be injurious to plants. In sand and nickel solution experiments, Vanselow (1966) demonstrated that at 0.5 to 1.0 mg/l, nickel is toxic to a number of plants. The toxicity exhibited to plants by nickel varied widely with the species. McKee and Wolf (1963) indicated that nickel was extremely toxic to citrus. Chang and Sherman (1953) found that tomato seedlings were injured by 0.5 mg/l nickel. Hop plants were shown to be injured by nickel at 1.0 mg/l (Legg and Ormerod, 1958). Plants exhibiting less susceptibility to nickel were: oats, with toxic effects at 2.5 mg/l (Crooke, 1954); corn at 2 mg/l; and tobacco with no toxic effects at 3.0 mg/l (Soane and Saunders, 1959). Concentrations of nickel at or below 100 ug/l should not be harmful to irrigated plants.

#### 7. PBHC (Petrochemicals)

It has been estimated that between 5 and 10 million metric tons of oil enter the marine environment annually (Blumer, 1970). A major difficulty encountered in the setting of criteria for petroleum products is that these are not definitive chemical categories, but include thousands of organic compounds with

varying physical, chemical, and toxicological properties. They may be volatile or nonvolatile, soluble or insoluble, persistent or easily degraded.

Field and laboratory evidence has demonstrated both acute lethal toxicity and long term sublethal toxicity of oils to aquatic organisms. Events such as the Tampico Maru wreck of 1957 in Baja, Calif., (Diaz-Piferrer, 1962), and the No. 2 fuel oil spill in West Falmouth, Mass., in 1969 (Hampson and Sanders, 1969), both of which caused immediate death to a wide variety of organisms, are illustrative of the lethal toxicity that may be attributed to oil pollution.

Because of the wide range of compounds included in the category of oil, it is impossible to establish meaningful 96-hour  $LC_{50}$  values for oil and grease without specifying the product involved. However, the data show that the most susceptible category of organisms, the marine larvae, appear to be intolerant of petroleum pollutants, particularly the water soluble compounds, at concentrations as low as 0.1 mg/l.

The long term sublethal effects of oil pollution include interferences with cellular and physiological processes such as feeding and reproduction and do not lead to immediate death of the organism. Disruption of such behavior apparently can result from petroleum product concentrations as low as 10 to 100 ug/l.

Bioaccumulation of petroleum products presents two especially important public health problems: (1) the tainting of edible, aquatic species, and (2) the possibility of edible marine organisms incorporating in their tissues the high boiling, carcinogenic polycyclic aromatics. Nelson-Smith (1971) reported that 0.01 mg/l of crude oil caused tainting in oysters. Moore, et al. (1973) reported that concentrations as low as 1 to 10 ug/l could lead to tainting within very short periods of time. It has been shown that chemicals responsible for cancer in animals and man (such as 3,4-benzopyrene) occur in crude oil

Blumer, 1970). It has also been shown that marine organisms are capable of incorporating potentially carcinogenic compounds into their body fat where the compounds remain unchanged (Blumer, 1970).

Oil pollutants may also become incorporated into sediments. There is evidence that once this occurs in the sediments below the aerobic surface layer, petroleum oil can remain unchanged and toxic for long periods, since its rate of bacterial degradation is slow. For example, Blumer (1970) reported that No. 2 fuel oil incorporated into the sediments after the West Falmouth spill persisted for over a year, and even began spreading in the form of oil-laden sediments to more distant areas that had remained unpolluted immediately after the spill. The persistence of unweathered oil within the sediment could have a long term effect on the structure of the benthic community or cause the demise of specific sensitive important species. Moore, et al. (1973) reported concentrations of 5 mg/l for the carcinogen, 3,4-benzopyrene in marine sediments.

Because of the great variability in the toxic properties of oil, it is difficult to establish a numerical criterion which would be applicable to all types of oil. Thus, for a given discharge situation, an upper allowable limit of an individual petrochemical should be determined by applying a factor of 0.01 to the lowest continuous flow 96-hour  $LC_{50}$  for several important and sensitive resident species.

There is a paucity of toxicological data on the ingestion of the components of refinery wastewaters by humans or test animals. It is apparent that any tolerable health concentrations for petroleum-derived substances far exceed the limits of taste and odor. Since petroleum derivatives become organoleptically objectionable at concentrations far below the human chronic toxicity, it appears that hazards to humans will not arise from drinking oil-polluted waters (Johns Hopkins University, 1956; McKee and Wolf, 1963). Oils of animal or vegetable origin generally are nontoxic to humans and aquatic life.

In view of the problem of petroleum oil incorporation in sediments, its persistence and chronic toxicity potential, and the present lack of sufficient toxicity data to support specific criteria, concentrations of oils in sediments should not approach levels that cause deleterious effects to important species or the bottom community as a whole.

#### 8. Benzene, Toluene, Xylene (BTX)

Benzene is a clear, volatile, colorless, highly flammable liquid with a characteristic odor and is slightly soluble (0.82 g/liter). As a result, this nonpolar metal can bioaccumulate and has a high lipid solubility. It is also rather mobile in the environment. Although benzene is associated with acute poisoning which results in nausea, vomiting, ataxia, followed by depression and coma, the major concern is its chronic effects as a hematoxin. The available evidence does not demonstrate carcinogenicity in animals, but there is strong evidence implicating benzene as a cause of human leukemia. The NAS (1980) has recommended a SNARL of 12.6 mg/liter but this ignores mutagenic and suspected carcinogenic effects. The NAS was not able to recommend a criterion for protection from chronic exposure due to what it considered to be a lack of evidence. The EPA has considered setting ambient water criteria based on cancer risk levels with a preference for a zero limit to protect human health. For a cancer risk of  $10^{-5}$  (one additional cancer for every 100,000 persons exposed), a criterion would be 6.6 ug/liter. Similarly, a risk of  $10^{-6}$  would be associated with a criterion of 0.66 ug/liter. For the protection of marine aquatic life, a criterion of 5,100 ug/l on an acute basis is suggested.

Toluene is a clear, colorless, non-corrosive liquid with an odor of benzene. It is used in the manufacture of organic substances and as a solvent in the extractions of various principles from plants. The oral LD<sub>50</sub> for white rats was reported as 7000 mg/kg of body weight.

The concentrations of toluene that proved lethal to fish in clear water have been reported from 10 to over 90 mg/l, depending on the temperature and the species of fish.

Toward lower organisms, the threshold of toxicity for *Daphnia* occurred at 60 mg/l, for the diatom *Scenedesmus* at 120 mg/l, and for *E. coli* at 200 mg/l. It has been reported that 10 mg/l of toluene gave a large reduction in the photosynthetic activity of the giant kelp (*Macrocystis pyrifera*) in a 96-hour exposure. The EPA has suggested marine aquatic criterion for acute and chronic toxicity of 6,300 ug/l and 5,000 ug/l respectively. These levels would be lower for more sensitive species not tested. To protect human health, the criterion is 14.3 mg/l.

Xylene is a constituent of coal tar, with the commercial form being a mixture of the three isomers, o-, m-, and p-xylene. It is a flammable liquid that is insoluble in water. Commercially it is used as a solvent and cleaning agent, and in the manufacture of dyes and organics. The oral LD<sub>50</sub> for white rats is reported as 4,300 mg/kg of body weight.

The concentrations of xylene reported to kill fish vary from 10 to 90 mg/l, depending on the species, temperature, and isomer. In general, m-xylene appears to be most toxic and o-xylene least toxic. In Lake Huron water at 12°C, a concentration of 5 mg/l of m-xylene had no apparent effect on rainbow trout or sea lampreys during a 24-hour exposure, but this concentration caused illness to the bluegill sunfish within 10 hours. No criteria have been set for xylenes but EPA has suggested a permissible ambient goal of 6,000 ug/l based on health effects.